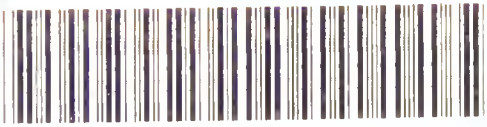

SURGICAL ANATOMY.

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FOR STUDENTS.

BY

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PREFACE.

This work contains the substance of a series of demonstrations, delivered by myself, to students in course of preparation for the final examinations.

The book is intended for students to use with the living model. The study of Surgical Anatomy from illustrations alone is answerable for many of the rejections in this subject at the final examinations. No picture or description will enable a student to instantly compress the subclavian artery, place his finger on a given prominence, or name a deeply-seated tendon. These demonstrations have always been given upon the living subject, and I insist that students should actually feel and delineate the structures discussed.

The allusions to operations and injuries are intended to give interest to the text. Knowledge of a surgical operation, to be of practical value, should be complete in every detail. The scope of a work of this nature, forbids that it should in any way be regarded, as a guide to the operations of Surgery.

Slight discrepancies, often observed in books on Surgical Anatomy, in the positions of the different viscera, are due to the fact, that the organs are often altered in situation from

disease, spinal curvatures, and even congenital peculiarity. The delineation of muscles is hard to effect with mathematical accuracy, and the descriptions in the text are merely useful as rough guides. It is hoped, however, that when the student attempts to follow them he will be led to form a mental picture of the parts hidden from view. The ability to do this well, leads to future confidence as an operator.

A complete work on Surgical Anatomy would be a volume of portentous dimensions. There are few anatomical points which have not their clinical bearings. It is hoped that many matters of real practical importance are touched upon in this book, which is not intended to rival larger treatises.

In conclusion, I owe my best thanks to Mr. Herbert Waterhouse, F.R.C.S., Demonstrator of Anatomy at the Medical School of Charing Cross Hospital, and formerly Demonstrator in the University of Edinburgh. He has read most of the chapters, and has drawn my attention to some errors and many ambiguities of description.

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SURGICAL ANATOMY.

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CHAPTER I.

THE HEAD AND FACE.

Bony "landmarks" of the Head.—The occipital protuberance is the thickest part of the cranial vault. It corresponds internally with an eminence and a depression which is the point of meeting of six sinuses. If you draw a line from a little to the right of the occipital protuberance, over the vault of the cranium to the root of the nose, you delineate the course of the superior longitudinal sinus. A curved line drawn outwards from the occipital protuberance to the front border of the mastoid process, curving downwards at its termination, marks the course of the lateral sinus.[1] A line drawn straight downwards from the protuberance towards the foramen magnum, is over the course of the occipital sinuses. The frontal air sinuses form the supra-orbital prominences seen on either side of the root of the nose. They are usually absent in children, and communicate with the middle meatus of the nose by the infundibulum. The left is generally the larger. A heavy blow here may drive in the front wall of the frontal sinuses, and thus a depressed fracture of the outer table only of the skull takes place. Severe catarrh of these cavities is some-

[1] This is only a rough guide, the lateral sinus being liable to frequent deviations.

times met with; excessive discharge of watery fluid then occurs from the nostril; insects have also crawled into them. They may be the seat of exostosis.

The external angular process of the frontal bone is plainly to be felt, articulating with the malar. About one and a half inches behind this prominence, and a little above it, is the anterior-inferior angle of the parietal bone. Here also articulate the tip of the great wing of the sphenoid, the squamous bone, and the frontal—this point being termed the pterion. The coronal suture corresponds to a line drawn transversely across the vertex, from the pterion on one side to the pterion on the other. It separates the frontal from the parietal bones. The sagittal suture separates the parietal bones, and corresponds to the line of the superior longitudinal sinus. A line drawn on either side, from the superior angle of the occipital bone to the tip of the mastoid, will mark the lambdoid suture, separating the parietal from the occipital bones. The point of junction of the sagittal and coronal sutures is termed the bregma; the point of junction of the sagittal and lambdoid sutures, the lambda. A line drawn from the lower end of the lambdoid suture to the pterion, will roughly indicate the course of the suture between the mastoid and parietal, the squamous bone and the parietal, the sphenoid and the parietal. There are six fontanelles. Besides these, singular gaps and fissures, the result of congenital peculiarity or disease, may be found on the cranial vault. All the fontanelles should be closed soon after birth, the anterior by the end of the second year. Small "wormian" bones may be found in these situations. The skull and brain are best tapped, in cases of hydrocephalus, at a point in the coronal suture, to the side of the anterior fontanelle.

Define the upper margin of the orbit, and feel for the supra-orbital notch, situate at the junction of its inner and middle thirds. If you draw a line thence downwards and inwards to the lower jaw opposite the second bicuspid tooth, this will nearly cross the infra-orbital and mental foramina. Through

these apertures, branches from the three different divisions of the fifth nerve appear on the face. The zygoma is formed by the malar bone articulating with the zygomatic process of the temporal bone. The masseter is attached to it below. Both layers of the temporal fascia are attached to it above. The temporal muscle passes beneath it, the temporal artery over it. This vessel can be best compressed against the zygoma, in cases of bleeding from the scalp. If you trace the zygoma backwards, you will arrive at the temporo-maxillary articulation, formed between the condyle of the jaw and the glenoid fossa. In front of the articulation is the "eminentia articularis," which tends to prevent displacement of the jaw forwards. The ligaments of the articulation are the capsular, external and internal lateral, and inter-articular cartilage. To these may be added the stylo-maxillary. The capsule is thickest externally. The cartilage has some fibres of the external pterygoid inserted into it. There are two synovial membranes in this joint, above and below the cartilage. Behind the articulation is a process of the parotid gland, and the bony wall of the auditory canal. Internally is the internal maxillary artery, the auriculo-temporal nerve, and the inferior dental artery and nerve. These structures, with the external pterygoid, separate the internal lateral ligament from the articulation. The movements of the joint are very extensive—forwards, backwards, and from side to side. In addition to this, a gliding movement of the condyles takes place, as exemplified during the trituration of the food. Owing to the close relation between the condyle of the jaw and the auditory canal, necrosis of the latter may affect the former, leading to abscess and disintegration of the joint. The ordinary displacement of this joint is forwards. The condyle has also been driven through the base of the skull. When the dislocation forward occurs, as in deep yawning, the internal pterygoid, masseter, and temporal muscles, raise the bone and force the coronoid process upwards beneath the zygomatic arch. The mouth is opened by the depressors of the lower jaw, the mylo-hyoids, genio-hyoids, and digastrics.

The mouth is shut by the elevators of the jaw, especially the temporal and masseter muscles.

The mouth being widely open, you can feel the mylo-hyoid ridge running along the inner surface of the jaw. Below and behind the last molar tooth, firm pressure will elicit a painful sensation, indicating the position of the lingual nerve, which may here be divided. The jaw being still further depressed, you can recognise the dental prominence with the insertion of the internal lateral ligament. Here the dental artery and nerve enter the dental foramen. This point is about opposite the junction of the upper and middle thirds of the ramus externally. Behind and internal to the last molar tooth of the upper jaw you may feel the tip of the hamular process, and, descending from it, the pterygo-maxillary ligament. Just in front of the hamular process is the orifice of the posterior palatine canal, through which the large descending palatine artery courses. In troublesome hæmorrhage from the palate, it may be needful to plug this aperture. If the finger be passed behind the soft palate, into the orifice of the posterior nares, the basilar process of the sphenoid will be above, the horizontal plate of the palate bone below, the vertical plate of the palate bone externally, the vomer and rostrum of the sphenoid internally. The orifice of the Eustachian tube is about half-an-inch behind the end of the turbinal. There are twenty temporary, and thirty-two, so-called, permanent teeth. The front temporary incisors of the lower jaw usually appear at about the seventh month, the second molars by the end of the second year. About the sixth year there should be forty-eight teeth in the jaws, all the temporary set and the crowns of the permanent, with the exception of the last molars. At this age, therefore, it is important that the mouths of children should undergo dental examination. The first permanent molar appears at six years, the incisors at seven or eight, the anterior bicuspid at nine, and so backwards, in regular gradation, until we arrive at the third molar, which may appear between eighteen and twenty-six.

Nasal Fossæ.—If you well dilate the anterior nares, and throw a strong light into them, you will see on the outer wall the inferior turbinate bone, and in some cases the middle turbinate. The inner wall is anteriorly formed by the vomer and triangular cartilage. Note that the turbinate bones are situated at a much higher level than one is apt to suppose; the attachment of the inferior being on a level with the lower margin of the orbit, the middle with the inner canthus of the eye. The foramina which transmit vessels and nerves into the nasal fossæ are covered with mucous membrane in the recent state. The nasal duct opens into the inferior meatus; the orifice of the antrum and the infundibulum into the middle meatus; the sphenoidal sinus and posterior ethmoidal cells into the superior meatus. The roof of the nasal fossæ is formed by the body of the sphenoid, the cribriform plate of the ethmoid, and the nasal spine of the frontal and nasal bones. The cribriform plate is thin and easily perforated. Instruments must therefore be used with caution towards the roof of the nose. In cases of necrosis and ozæna, meningitis may ensue, or purulent phlebitis of the cerebral sinuses, which communicate by large emissary veins with the veins of the nose. The olfactory nerve is mainly distributed over the upper third of the septum, and the superior and middle spongy bones. The lower spongy bone can consequently be removed, without direct interference with the sense of smell. The first and second divisions of the fifth supply the nasal fossæ with common sensation. The numerous arteries are derived from the internal maxillary, ophthalmic and facial. The extensive cavernous plexus of veins, which is the seat of bleeding in epistaxis, communicates freely with the superior longitudinal sinus. These veins empty principally into the facial and internal maxillary veins. In cases of engorgement of the head and neck, as in obstructive heart disease, or pressure from thoracic or cervical tumour, profuse epistaxis is common, and gives great relief. The lymphatics empty, some into the glands of the neck, others into the

retro-pharyngeal glands. A long probe, introduced along the floor of the nose, through the pharynx, would strike the body of the atlas. The roof of the nose may be deficient anteriorly, and this is a favourite situation for meningocele. This tumour is congenital, appears at the root of the nose, pulsates indistinctly, is partly reducible, surrounded by a bony rim, and swells up when the child cries violently.

The Antrum.—The central cavity is pyramidal in shape. Its base corresponds to the floor of the nose, and here it communicates by an aperture, small in the living subject, with the middle meatus. The aperture is situated at the upper part of the base of the antrum, and this portion of bone is often infiltrated with growth, in cases of malignant disease of the antrum. The apex of the antrum extends a variable distance into the malar process. Its front wall is the facial surface of the maxilla; its upper wall is the orbital plate. Below is the palatal process, behind it the zygomatic surface of the jaw and the zygomatic fossa. The antrum is lined with a mucous membrane filled with glands, which may take on "cystic" disease,[1] while abscess of the cavity may result from necrosis of bone, or disease of the molar teeth. This cavity is too often the seat of serious tumours, generally malignant in nature. These bulge the walls of the antrum, especially the facial, the orbital, and palatal. A bulging cheek, a prominent eyeball, and a depressed palate, mean distension of the antrum by fluid or growth. Foreign bodies of extraordinary size and weight may remain in the antrum after an injury to the face. In obstinate "neuralgia" of the dental nerves, not due to diseased teeth, or in neuralgia of the superior division of the fifth, after an injury, the cavity of the antrum may need exploration. I have assisted to remove from the antrum a portion of the breech of a gun barrel, which had long remained in the antrum after a severe face

[1] This view, though commonly taught, is probably incorrect. Most cysts of the antrum occur in the anterior wall, and bulge backwards into the cavity.

injury, causing terrible neuralgia. Its existence was quite unsuspected, and, on feeling it with the probe, it was thought to be a portion of necrosed bone. The real nature of the substance was only proved by extraction. If the front wall of the antrum were trephined by a large instrument, and the infra-orbital nerve followed backwards, this trunk would lead you to the pterygo-maxillary fossa and Meckel's ganglion. The best situation to tap the antrum is just above the second bicuspid tooth, or through the socket of the second molar tooth, should that be diseased and need extraction. It is well to perforate the antrum in any case where the diagnosis of tumour is not certain, before removal of the jaw is effected.

Orbit.—The orbital cavity is irregularly pyramidal. The apex corresponds to the optic foramen, through which the optic nerve and ophthalmic artery enter the orbit. The inner wall is formed by the *os planum* of the ethmoid articulating with the lachrymal and maxillary bones; the outer wall by the great wing of the sphenoid and the malar bones. The roof is formed by the orbital plate of the frontal and the lesser wing of the sphenoid, the floor by the orbital plate of the maxilla and palate. The roof of the orbit is so thin that sharp instruments may readily pierce it, and fatally injure the brain. There may even be no external mark, the injury being inflicted beneath the upper eyelid. Look with grave suspicion on any stab or puncture made in this region. Pieces of slate pencil, pen nibs, and the ferrule of a walking cane, are among the articles that have been unexpectedly found after death imbedded in the brain in these cases. The connection of the floor of the orbit with the antrum has been touched upon. A fracture of the outer wall, across the malar bone, will cause hæmorrhage into the orbit, and hence will stimulate a fracture of the anterior fossa of the skull. Tumours may grow into the orbit and displace the globe, from the antrum beneath, the ethmoidal cells internally, or the cranial cavity behind. A growth may likewise invade

the orbit from the zygomatic or spheno-maxillary fossa, passing through the spheno-maxillary fissure, and an orbital growth may, by the same route, implicate these cavities.

The Interior of the Cranium.—The dura mater is intimately adherent to the bones, especially at the base, and from the meningeal vessels the osseous structures receive their chief vascular supply. Hence in scalp wounds, where the pericranium is torn away from the bones, the latter seldom necrose, the blood supply from the interior being so free. Hæmorrhage between the bone and dura mater, the result of violence, usually occurs over the area of distribution of the middle meningeal artery, near the anterior-inferior angle of the parietal bone. More rarely the source of bleeding is from the lateral sinus. The symptoms come on gradually, and not suddenly, as is the case in depressed bone. On exposing the dura mater in the living subject, its outer surface is marked by numerous branching vessels, and it is a little filamentous and rough; the pacchionian bodies seen upon it must not be mistaken for the effects of disease. The dura mater may present two distinct pulsations, the one synchronous with the pulse of its arteries, the other with the respiration—rising on expiration, sinking on inspiration. This is by no means always observed.

Between the dura mater and arachnoid is the sub-dural space, in which inflammatory formations, or extravasations of blood, are sometimes found. Between the arachnoid and the pia mater is the sub-arachnoid space. This is filled by the cerebro-spinal fluid, and the space communicates with the cavity of the fourth ventricle, through the foramen of Majendie in the floor of the former. Hilton has well pointed out that the posterior two-thirds of the base of the brain rest on fluid, not on bone. This important fact explains those frequent and obscure cases of fracture of the base of the skull, where symptoms are at first absent or indefinite. The fracture traverses the bones, but the brain above is untouched. Gradually blood fills the sub-arachnoid space, presses upon

the base of the brain, and stupor and coma supervene, terminating in death. If bleeding does not prove fatal, meningitis is another danger to be feared, for the fracture generally communicates with the air through the ear or pharynx.

The sub-arachnoid space, too, is often the seat of inflammatory effusions, and in meningitis is filled by yellow or green pus. The interior of the ventricles commonly participates in the mischief. Fracture of the base of the skull by *contre-coup* is said by the best authorities not to occur. It is otherwise in laceration of the brain by *contre-coup*, which is quite common. The parts of the base of the cerebrum in contact with the bones are the frontal lobes, which rest upon the small wings of the sphenoid and orbital plates of the frontal. Violent blows on the occiput or vertex jolt this part of the brain on the bones, and laceration of it is the consequence. Thence may follow slow and insidious bleeding into the sub-arachnoid space, and gradual coma.

Important matters to recollect regarding the intracranial circulation are the following: The circle of Willis at the base is formed posteriorly by the basilar and two posterior cerebral, on either side by the internal carotid and posterior communicating, in front by the anterior cerebral and anterior communicating arteries. Thus, if one carotid is tied in the neck, the blood instantly rushes round the circle of Willis, and the circulation to the brain is usually thus maintained. The main bulk of the corpus striatum is supplied by the middle cerebral artery, numerous twigs of which pierce the anterior perforated space. One of these so often ruptures in the aged, or those who have diseased vessels, that it is termed the artery of cerebral hæmorrhage. The anterior cerebral supplies the anterior part of the corpus striatum. The optic thalamus is supplied externally by the posterior cerebral artery, internally by twigs from the posterior communicating.

The upper frontal convolutions are supplied by the anterior cerebral, the lower by the middle cerebral. In the third left

frontal convolution (Broca) is situate the faculty of speech. When the left middle cerebral is blocked by an embolus, which curiously often happens, aphasia is the result, with right hemiplegia, from implication of the inner part of corpus striatum. Practically speaking, all the parietal convolutions are supplied by the middle cerebral artery. The same artery supplies the two upper temporo-sphenoidal convolutions, the lower convolution being supplied by the posterior cerebral.

The lateral and inferior petrosal sinuses unite outside the cranium to form the internal jugular vein, and by this means most of the venous blood leaves the interior of the cranium. But there are numerous emissary veins, which also leave by the skull by the fissures and foramina. These are of surgical importance, because purulent phlebitis of them from extra-cranial conditions, as facial carbuncle, may readily induce meningitis and pyæmia. Again, leeches applied over some of them act powerfully, by directly drawing blood from the meninges. These veins in life are very large, and most profuse bleeding may occur from them if wounded. This is the most embarrassing complication of neurotomy of the third division of the fifth nerve, close to the skull. If the internal jugular veins were tied, the venous blood would find its way out of the skull by numerous apertures. In front there is a free communication between the superior longitudinal sinus and the veins of the nose through the foramen cæcum ; there is also a free communication between the cavernous sinus and the facial vein through the ophthalmic. On the vertex, the longitudinal sinus communicates with the veins of the scalp through parietal foramina. Veins pass from the lateral sinus through the mastoid and posterior condyloid foramina to join with the radicles of the vertebral veins. Thrombosis and inflammation about the mastoid vein is looked upon as an important sign of thrombosis of the lateral sinus.

The petrosal sinuses communicate with the veins of the ear, the transverse sinus communicates with the anterior spinal veins. There is frequently a small aperture in the

squamous bone, through which a communication occurs between the inside of the skull and the temporal veins. A pair of veins pass out of the foramen spinosum and foramen ovale, also to join the pterygoid plexus. Veins pass from the cavernous sinus to the pterygoid plexus. Large emissary veins accompany the internal carotid artery. Besides these there are others of various size, which pass out through nameless foramina.

Relations of the Brain to the Skull.—The relation of the sulci and convolutions of brain to the cranium is now a matter of much surgical importance. If you take a tape and carry it round the head close to the eyebrows, through the external angular process of the frontal bone and the centre of the meatus auditorius externus to the occipital protuberance, you about indicate the level of the lower margin of the cerebrum. The lobes of the cerebellum lie below the occipital protuberance. The fissure of Sylvius bifurcates about an inch behind, and a quarter of an inch above, the external angular process of the frontal bone. This point corresponds to the pterion before mentioned. The ascending limb passes upwards parallel with the coronal suture for a good inch, the horizontal limb runs backwards and upwards towards the parietal eminence for three inches. The horizontal limb of the fissure of Sylvius marks the upper limit of the temporo-sphenoidal lobe. From the base line before given draw two vertical lines upwards to the longitudinal sinus, the one in front of the meatus, the other behind it, from the posterior margin of the mastoid; a quadrilateral is thus formed, and the diagonal from the posterior-superior to the anterior-inferior angle nearly corresponds to the fissure of Rolando. The fissure of Rolando, if a little prolonged, would touch the superior longitudinal fissure about seven inches behind the root of the nose. Between the fissure of Rolando and the ascending limb of the fissure of Sylvius lies the ascending frontal convolution; immediately behind the fissure of Rolando is the ascending parietal convolution. The parieto-occipital fissure is about an

inch long, and directed outwards nearly at right angles to the superior longitudinal fissure, from a point just in front of the lambda.

A trephine applied immediately behind the external angular process would be in front of the line of the middle meningeal artery, and would expose the inferior frontal convolution. A trephine aperture just above the base line, two inches behind the external angular process, would expose the tip of the temporo-sphenoidal lobe. A trephine applied half-an-inch above the external auditory meatus would expose the temporo-sphenoidal lobe, and the middle fossa of the base of the skull. Here abscesses, in connection with the disease of the petrous bone, are usually formed and evacuated.

A trephine applied about three-quarters of an inch from the longitudinal sinus would expose the first frontal convolution; which runs backwards, parallel with the longitudinal sinus, to about an inch in front of the lambda.

A trephine applied over the frontal part of the temporal ridge would expose the second frontal convolution.

A trephine applied half-an-inch in front of the fissure of Rolando would expose part of the ascending frontal convolution. A trephine applied half-an-inch behind the fissure of Rolando would expose the ascending parietal convolution.

In the area bounded by the longitudinal fissure in the middle line, the horizontal limb of the fissure of Sylvius below and the ascending limb in front, behind by the parieto-occipital fissure, lies (1) the ascending frontal convolution, immediately behind the ascending limb of the fissure of Sylvius; (2) the ascending parietal, behind the fissure of Rolando; (3) the superior parietal, between the fissure of Rolando and the parieto-occipital fissure, on either side of the longitudinal fissure.

The motor functions of the cortex of the brain, so far as position is concerned, are still under consideration. When one studies the statements of equally eminent observers, one cannot but be struck with the serious divergence of opinion

expressed, and it seems that the matter is hardly exact enough at the present time to lay down hard and fast rules for the guidance of students. In trephining, therefore, over the parietal or frontal area for a supposed tumour, it is well to use a large instrument, so as to allow for slight errors of diagnosis in localisation. It is in this area of the brain that pressure by blood or depressed bone is so common. Here, too, tumours are sometimes located. Some kinds of epilepsy are caused by cortical pressure, the "aura" involving the part in connection with the portion of the cerebrum affected—as the arm, thumb, angle of the mouth.

The Scalp.—The principal peculiarities about the hairy scalp are as follows:—The main trunks of the vessels and nerves run beneath the skin, and their branches pass downwards to the sub-aponeurotic cellular tissue. The reverse is the case in other parts of the body. As a consequence, severe bleeding takes place from scalp wounds, which can usually be easily checked by pressure; and, in erysipelatous and like affections of the scalp, the inflammatory swelling may cause strangulation of the small vessels, and serious sloughing of the cellular tissue. The tendinous aponeurosis of the occipito-frontalis muscle covers the whole vertex and sides of the head, it is intimately adherent to the fascia and skin above, and below is separated from the pericranium by lax connective tissue. This permits a free sliding movement of the scalp on the cranium, and in blows and crushes the bone is thus protected. In this lax tissue, hæmatomata of a large size may form, especially in children; and in scalp wounds, the surgeon cannot be too careful that foreign bodies—as pieces of brick, china, dirt, or hair—do not remain imbedded. The frontal part of the occipito-frontalis muscle blends with the orbicularis palpebrarum, corrugator supercilii, and pyramidalis muscles. A section of the scalp, as made for trephining, would divide the skin and intimately adherent superficial fasciæ, the vessels and nerves, the occipito-frontalis tendon, the cellular tissue, and pericranium.

If a knife were drawn round the head, from the root of the nose to the occiput, the following eight cutaneous nerves would be divided, from before backwards: the supra-trochlear and supra-orbital, the temporo-malar, the auriculo-temporal, branches from all the divisions of the fifth. Above the auricle, the auricularis magnus, from the second and third cervical, the small occipital, the great occipital, and, sometimes, a cutaneous branch of the third cervical near the occiput.

The auricular twig of the vagus would probably be below the incision.

The vessels cut would be the frontal and supra-orbital, the anterior and posterior superficial temporal, the deep temporals in the temporal fossa, from the internal maxillary; the posterior auricular, and, finally, the occipital, which traverses the scalp midway between the mastoid and occipital protuberances. The branches of these "arteries of the scalp" become enormously enlarged in such affections as aneurism, by anastomosis, and fibrous tumours. They can be compressed by an elastic fillet passed round the head. The lymphatics of the scalp follow the distribution of the arteries—those of the temporal area going to the zygomatic and parotid glands; those of the occipital to the mastoid, auricular, and posterior cervical glands. These glands are commonly enlarged in such affections as eczema of the scalp. The large number of sebaceous glands in the scalp make sebaceous cyst the commonest form of tumour. These are situate in the skin, not under it, are often hereditary and multiple, and sometimes marked with a tiny black dot on the surface, the orifice of the obstructed gland.

In the neighbourhood of the orbit, dermoid cysts are common. These are beneath the skin, and generally lie deeper than you expect, perforating the bone, or passing among the muscles of the orbit. They contain sebaceous matter, epidermic cells, and hair, which latter is sure evidence of their congenital nature. They are usually looked upon as produced by involution of the ectoderm.

Temporal and Parotid Fasciæ.—The temporal fascia is thick and dense, being attached to the whole temporal ridge on the parietal and frontal bones; below, it splits into two layers, where it is attached to the zygoma. Between these layers is some loose fat and the orbital branch of the middle temporal artery. The temporal muscle arises from the inner surface of the upper two-thirds of the fascia. The temporal fascia is separated from the skin by the thin epicranial aponeurosis and the auricular muscles, and the temporal vessels. This fascia being very dense, prevents matter from penetrating it, in cases of suppuration. A deep-seated abscess in the temporal fossa is apt to point and burst inside the mouth near the pterygoid processes, or even to burrow into the neck.

The parotid and zygomatic fascia is very thick and dense, and may be looked upon as a continuation of the cervical fascia. It is attached superiorly to the zygoma, and is intimately adherent to both the masseter and the parotid gland. Behind it forms the stylo-maxillary ligament, which passes from the apex of the styloid process to the angle of the jaw, and separates the parotid from the sub-maxillary gland. The unyielding nature of this fascia makes a parotid abscess a very serious matter. The pus cannot escape superficially, so it is forced to burrow upwards beneath the zygoma, or into the mouth or pharynx. Occasionally it breaks through the layer of fascia attached to the jaw below, and points in the neck. Agonising pain in the course of the twigs of the auriculo-temporal nerve is common in these cases, and the joint of the jaw is stiff, inflamed, and sometimes even disintegrated by pus. No fluctuation may be detected. An incision to open a parotid abscess should be horizontal, about an inch long, situated below the lobule of the ear, and not commenced posterior to the ascending ramus of the jaw. The incision should divide the fascia only, and a way to the abscess be found with the finger.

Temporal Muscle.—The temporal muscle is the shape of a

fan. The apex corresponds to the coronoid process of the jaw beneath the zygoma, at the junction of the anterior and middle thirds; the base to a curved line drawn along the temporal ridge from the angular process of the frontal bone to the posterior root of the zygoma. You can thus easily map it out on the surface, if required to do so. Superficially, the muscle is covered by fat, the temporal fascia, the zygoma, the masseter, the aponeurosis of the occipito-frontalis, the muscles of the ear, and the temporal vessels. Its deep surface is in relation with the temporal fossa, the external pterygoid process and muscle, the buccinator, the maxillary artery, and its deep temporal branches. These latter ascend in the deeper parts of the muscle to the temporal fossa. It is supplied by the inferior maxillary nerve.

Buccinator.—The buccinator is somewhat quadrilateral in outline, closing the interval between the jaws, and lying in front of the ramus of the jaw, beneath the zygomatic, masseter, and temporal muscles. Its upper margin corresponds to a line drawn along the alveolar process opposite the three molar teeth, its lower margin along the lower jaw to a similar extent. Behind, it arises from the pterygo-maxillary ligament, which separates it from the superior constrictor. Steno's duct perforates the buccinator opposite the second molar tooth of the upper jaw, and the facial vessels and nerves pass over it. Internally, the muscle is merely separated from the mouth by mucous membrane. Its motor nerve is derived from the facial, being the only special muscle of mastication thus furnished with nerve supply. The buccal twig of the inferior maxillary which enters it is looked upon by most observers as purely sensory. The loose fat which lies between this muscle and the jaw, or between it and the masseter, may be the seat of a deep fatty tumour. This being sub-fascial is often puzzling, inasmuch as it closely simulates a chronic abscess.

Masseter.—This muscle is almost quadrilateral in outline, and is directed downwards and backwards. Its upper border

corresponds to a line drawn along the zygoma from the malar bone; its lower border to a line drawn backwards along the jaw for two inches, commencing about one inch and a half in front of the angle. Completing the figure by parallel lines, the muscle will be roughly delineated. The posterior margin is considerably shorter than the anterior. The muscle is covered by the masseteric fascia, the orbicularis palpebrarum and zygomatic muscles. Steno's duct and the transverse facial artery cross it, and below these branches of the facial nerve. At its anterior margin lies the facial artery. Posteriorly, the parotid gland and its accessory portion, overlap the muscle to a variable extent. It overlaps the buccinator, and is separated from it by cellular tissue and fat. The masseter is supplied by the inferior-maxillary nerve.

Arteries and Veins of Face.—The facial artery crosses the jaw near the anterior margin of the masseter. Here it can be compressed, and here the veterinary surgeon feels the pulse of his patients. Its course is tortuous, but would be roughly delineated by a line drawn from the point above mentioned to the side of the nose, and upwards along this to the inner canthus of the eye. The branches of this vessel are numerous, and inosculate freely, so that wounds of the face bleed copiously, but also unite with the greatest readiness. Branches of surgical importance are the coronary vessels and the angular; the former lie beneath the mucous membrane of the lips, and need compression during operations for "hare lip" and epithelioma. The angular artery is apt to be wounded in removing cysts from the angle of the orbit, or in opening a lachrymal abscess. The bleeding from it is always troublesome to arrest.

The external carotid bifurcates into temporal and maxillary, opposite the neck of the condyle of the jaw. The temporal is the smaller branch.

The superficial temporal artery gives off the transverse facial branch. This crosses the side of the face immediately below the zygoma, and above Steno's duct. It is often wounded in removing "parotid tumours."

The middle temporal artery passes just above the zygoma and perforates the temporal fascia. This branch gives off the orbital twig, which continues its course above the zygoma. The infra-orbital artery is the terminal twig of the internal maxillary, and arrives on the face through the infra-orbital foramen. The principal surgical importance of these little vessels is in connection with plastic operations upon the face. It is most important so to cut the flaps that the vessels enter the base of them. The main surgical points regarding the internal maxillary artery and its branches are as follows. In its first part it lies close to the inner surface of the temporo-maxillary articulation, and is apt to be wounded in removal of the jaw or excision of the joint. The middle meningeal artery comes off from the vessel between the neck of the jaw and the internal lateral ligament, and runs upwards to the foramen spinosum. The inferior dental artery accompanies the nerve, and, in dividing the latter for neuralgia, this vessel is apt to cause some troublesome bleeding. The deep temporal arteries coming off from the second portion of the vessel, ascend in the temporal fossa through the muscle, and are divided in cutting down upon the skull in the neighbourhood of the pterion. Finally, the terminal branches of the internal maxillary artery are all apt to be divided or torn in removing the upper jaw. The bleeding from them is most profuse, but usually ceases on exposure to the cold air. In some cases it has proved fatal, and in huge vascular tumours of these parts, preliminary ligation of the external carotid is an excellent precaution.

The course of the facial vein corresponds to a line drawn from the inner angle of the orbit to the anterior border of the masseter. The frontal and supra-orbital veins join to form the angular, and the latter continues as the facial vein. The angular vein communicates freely with the ophthalmic vein, and thus with the cavernous sinus. As the facial vein passes downwards, it receives numerous venous twigs corresponding to the branches of the artery, and also large veins from the muscles. Below the jaw it receives the sub-mental, sub-maxil-

lary, and inferior palatine veins. Passing over the sub-maxillary gland, it empties itself into the internal jugular. The facial vein has no valves as a rule. Infective matters, and especially emboli, are readily carried to the jugular vein and general circulation. Thus, pyæmia supervenes on carbuncular or erysipelatous conditions of the face, and fatal results from pulmonary embolism have unexpectedly happened from injecting nævoid growths of the face with perchloride of iron. The free communication with the cavernous sinus renders the latter apt to participate in any morbid condition of the facial vein, as purulent phlebitis. In arterio-venous aneurism of the cavernous sinus, the arterial blood is pumped into the ophthalmic vein, and thence to the facial; a bluish, pulsating swelling appears over the face and cheek, with a distinct thrill and bruit. The common temporal vein descends over the zygoma, being a continuation of the superficial temporal vein. This trunk receives branches from veins corresponding to the twigs of the artery, and numerous others devoid of special name.

It joins over the neck of the condyle of the jaw in the superficial part of the parotid, with the internal-maxillary vein. This is a plexiform vessel of large size, receiving numerous branches from the pterygoid plexus of veins, and from venous radicles which accompany the branches of the internal-maxillary artery. The temporo-maxillary trunk descends, and near the angle of the jaw sends a large communicating branch to the facial. The continuation of the vein joins with the posterior auricular to form the external jugular. These veins are often plexiform, of large size, and bleed very freely when wounded. In excision of the jaw, or the removal of a large parotid growth, the temporo-maxillary vein is endangered. If the patient be "short-necked" and plethoric, and under the influence of ether, the hæmorrhage is most profuse and not easily controlled.

The facial nerve enters the base of the skull at the internal auditory meatus, passes through the aqueduct of Fallopius,

and emerges at the stylo-mastoid foramen. It is purely a motor nerve. Its great primary divisions are the temporo-facial and cervico-facial. The former holds sway over the muscles from the temple to the mouth, except the masseter and temporal. The latter supplies the muscles of the lower lip, with the platysma of the neck. The stylo-hyoid and posterior belly of the digastric are supplied by special branches. The facial nerve likewise supplies some of the muscles of the palate, though this has been lately disputed.

Horsley and Beevor, on stimulating the cut end of the facial nerve within the cranium, observed that the palate remained motionless. They found that the levator palati was entirely supplied by the spinal accessory nerve. The account given of the nerve supply of this muscle in the text-books, is therefore probably erroneous.

Suppose the facial nerve to be paralysed (Bell's *Paralysis*) by "ear disease" in the aqueduct of Fallopius, by a growth at the stylo-mastoid foramen, by division in an operation, or exposure of the face to a cold draught in railway travelling, all the muscles of expression on that side of the face will be paralysed, also the buccinator. The mouth will be drawn to the opposite side, and the affected side of the face will be blank and expressionless. The eye will be open and staring, it is also often inflamed from the entrance of dust. The tears run over the cheek, and the inferior nares on the affected side are often dry, while the aperture of the nostril seems diminished in size from paralysis of the nasal muscles. The patient cannot frown, smile, or knit the brows. He is unable to whistle, and, in mastication, the food collects between the affected cheek and the jaw, while saliva often trickles from the mouth. In course of time a curious phenomenon may occur. The mouth is drawn towards the *paralysed* side. There is a pathological reason for this circumstance. Paralysed muscles after a time shorten and contract, in consequence of interstitial fibrosis. The course of the facial nerve is represented on the face by a line drawn from the front border of

the mastoid, opposite the lobule of the ear, downwards and forwards across the face for about an inch. It divides into its two primary divisions before it crosses the jaw.

Any of the divisions of the fifth nerve may be paralysed from pressure or injury, or, more commonly, terrible neuralgia is experieneed in their areas of distribution from various eauses. A knowledge of their course and distribution is most essential to making a diagnosis or forming a rational plan of treatment.

The first or ophthalmie division of the fifth is purely a sensory nerve. It eomes off from the Gasserian ganglion, passes along the cavernous sinus, and enters the orbit through the sphenoidal fissure. It is apt to be implicated in its course by syphilitic exudations or bony growths. Through its eiliary branches it supplies the eyeball and cornea with sensation, its lachrymal branch supplies the laehrymal gland and integument of the upper lid, its frontal branch divides into supra-orbital and supra-trochlear, and those supply the hairy scalp as far back as the occiput with sensation. The last important branch is the nasal nerve, which terminates, as you know, by becoming cutaneous between the nasal bone and the cartilage of the nose, and supplying the skin over the tip of that organ. This nerve also sends twigs to the eyelids by its infra-trochlear branch, and to the mucous membrane of the septum and lower turbinate bones. Suppose a violent neuralgia to be caused in the first division of the fifth nerve by central or peripheral irritation, the patient will suffer from darting shooting pains over the brow and scalp, in the eyeball, and in the nose; or if the nerve is pressed upon or destroyed, these areas are anæsthetic, and the cornea sometimes sloughs and uleerates. Many are the clinical examples that eould be adduced, but perhaps the most important is acute glaueoma. Here the exudation into the vitreous humour worries the ciliary nerves, and the "referred" pains are experienced over the head, or down the nose; and henee an injudicious practitioner, who is ignorant of the more important facts of anatomy, is too apt to

treat the case as one of "facial neuralgia," a mistake which usually costs the patient his eyesight.

The second division of the fifth or superior-maxillary, is also a purely sensory nerve. It comes off from the Gasserian ganglion and leaves the cranium by the foramen rotundum, crosses the spheno-maxillary fossa, enters the orbit by the spheno-maxillary fissure, traverses the infra-orbital canal, emerges at the infra-orbital foramen, and divides into palpebral, nasal, and labial branches, which supply the skin of the face and side of the nose with sensation. Its temporo-malar branch pierces the outer wall of the orbit, and supplies the integument over the malar and temporal regions. By its three dental branches this nerve supplies with sensation the teeth of the upper jaw, with the gums and the adjacent mucous membrane. By tracing this nerve backwards along the infra-orbital canal you would arrive at Meckel's ganglion, to which it gives sensory roots.

If the trunk of the superior-maxillary nerve were divided soon after its exit from the foramen rotundum, sensation would be affected in the skin and conjunctiva of the lower eyelid, the side of the nose and face, and the skin and mucous membrane of the upper lip. The teeth and mucous membrane of the gums of the upper jaw would also be implicated.[1] The integument over the temporal region and malar bone would not be anæsthetic unless the lesion were situated close to the foramen rotundum, for the temporo-malar nerve comes off from the main trunk far back, and might thus escape.

It is rare for the whole inferior division of the fifth nerve to be completely paralysed, or the seat of neuralgia. One division is often affected while another escapes. This nerve is mixed in function. It supplies the masseter, temporal, and pterygoid muscles with motion, and also the anterior belly of the digastric and mylo-hyoid, through the mylo-hyoid branch of the inferior dental nerve. The buccal branch is sensory. Through the auriculo-temporal nerve the skin is

[1] It is remarkable how rarely this occurs in practice.

supplied with sensation at the auditory meatus, and over the temporal region. The buccal nerve is responsible for the cutaneous supply of the lower cheek. The inferior dental nerve, besides giving off the mylo-hyoid branch, supplies the teeth, the gums, and mucous membrane of the lower jaw, and, by its mental twig, the skin over the chin and lower lip. Terrible neuralgia sometimes occurs in these areas. The lingual nerve mainly supplies the papillæ of the anterior two-thirds of the tongue and the mucous membrane of the gums. In cases of cerebral disease, implicating this nerve, a patient may be unable to tell the difference between such substances as salt and sugar placed upon the anterior part of the tongue. Cases are constantly occurring in practice of various affections of the divisions of the inferior maxillary nerve, and it is only by a thorough knowledge of their course and distribution that such can be interpreted or explained.

Lymphatics.—The superficial lymphatics of the upper side of the face, and lower lid, pass to the glands over the parotid, which are therefore enlarged in epithelioma and syphilitic chancre of these parts. The lower lymphatics pass to the glands beneath the jaw, which also receive the lymphatics of the lips. These glands are therefore very frequently affected by secondary epithelioma forming stony, hard, fixed tumours in the sub-maxillary region.

The deep lymphatics of the orbit, nasal fossæ, roof of the mouth, temporal and zygomatic regions, join the internal-maxillary glands, which are placed round the artery beneath the jaw, and on the side of the pharynx.

The Parotid Gland.—The parotid gland weighs about six drachms. Draw a line along the posterior third of the zygoma to denote its upper boundary, another line from the zygoma downwards and backwards to the angle of the jaw to correspond with its front boundary. Its lower border corresponds with a line drawn from the angle of the jaw to the mastoid process. Behind, it extends deeply under the sterno-mastoid. It is covered in by the dense parotid fascia, and

has several lymph glands resting upon it. It rests upon the styloid process and its muscles, and advances beneath the jaw between the two pterygoid muscles. Above, it dips deeply into the glenoid fossa. At the angle of the jaw it is separated from the sub-maxillary gland by the stylo-maxillary ligament. On dissecting the gland from the surface, the large temporo-maxillary vein and its communications with the internal jugular would be first endangered. The external carotid artery passes through the gland, and divides opposite the neck of the condyle of the jaw into temporal and internal maxillary. The transverse facial artery emerges from the front of the gland just below the zygoma, the posterior auricular pierces it behind; still deeper lie the internal carotid artery, the internal jugular vein, the styloid process, and its muscles, and the glosso-pharyngeal nerve. The facial nerve traverses the lower part of the gland from behind, forwards and downwards.

Stenson's duct is about two and a quarter inches long, and of the diameter of a small quill, but its orifice will only admit a fine probe. This duct passes across the face a finger's-breadth below the zygoma, and pierces the buccinator opposite the second molar tooth of the upper jaw, in a line drawn from the lower part of the concha to midway between the lip and nose.

The anterior pillar of the fauces is formed by the palato-glossus muscle, the posterior by the palato-pharyngeus. The tonsil lies between them, and is separated from the internal carotid artery by the superior constrictor muscle and a fibrous aponeurosis. The tonsil is very vascular, receiving tonsillar branches from five arteries. These are the lingual, facial, and ascending palatine arteries. Several branches pass to the tonsil from the ascending pharyngeal artery, and palatine twigs descend to it, from the internal maxillary. In hæmorrhage, after removal of the tonsil, the bleeding usually comes from these branches of the external carotid, and not from the internal carotid, as students are apt to affirm. The

hæmorrhage will probably cease if you keep the mouth open, and the parts exposed to a cold draught, the patient sitting upright in a chair.

Lips.—The muscles which form the lips are the orbicularis, the levator anguli, and depressor anguli, oris, the buccinator fibres, on either side, the depressor labii inferioris, and levator labii superioris. In addition, the upper lip receives the fibres of the zygomatici, the risorius, and levator labii superioris alæque nasi. The nerves and vessels have received notice.

Tongue.—The muscles of the tongue are the superior, inferior, and transverse lingnales, and on either side the genio-hyo-glossus, hyo-glossus, stylo-glossus. All the muscles of the tongue are supplied by twigs of the hypo-glossal nerve. The tongue is protruded from the mouth by the posterior fibres of the genio-hyo-glossus, and drawn backwards by the anterior fibres. In hypo-glossal paralysis the tongue is protruded towards the paralysed side, and drawn back towards the sound side. The glosso-pharyngeal nerve supplies the mucous membrane and papillæ over the posterior third of the tongue, the lingual nerve the papillæ and mucous membrane of the tip, and anterior two-thirds of the organ. The exact position of the lingual vessels in the tongue is on either side of the middle line, between the hyo-glossus and genio-hyo-glossus. If the tongue be removed by operation, in addition to the muscles, nerves, and vessels mentioned, the mucous membrane would be divided, and especially those folds of it that connect the tongue with the epiglottis, the glosso-epiglottidean folds. The lymphatics of the anterior part of the tongue enter the sub-maxillary lymphatic glands. The lymphatics from the base of the tongue enter the deep carotid glands. These lymphatic glands are too often affected in carcinoma of the organ.

Salivary.—When the tongue is raised, the outline of the sub-lingual glands is perceptible. They form the elongated prominences seen on either side of the tongue in the floor of

the mouth, are covered with mucous membrane, and are in contact with the deep prolongation of the sub-maxillary gland below, being separated from the main body of that gland by the mylo-hyoid muscle. Internally, they rest upon the genio-hyo-glossus. The ducts of these glands either open along the ridge on the floor of the mouth, or join the Whartonian duct. The longest of them, named the duct of Bartholin, opens near the orifice of the duct of Wharton. The orifices of the ducts of Wharton are represented by two small papillæ, one on either side of the frænum of the tongue, in close apposition. When these ducts get blocked, as by chronic inflammation or calculus, a cyst forms beneath the tongue, containing glairy mucoid fluid. This condition forms one kind of ranula.

Cleft Palate and Hare Lip.—The developmental explanation of these deformities is briefly as follows. At a very early period the nasal and oral cavities are directly continuous. The palate is formed in greater part by horizontal growths from the superior-maxillary processes, which should meet in the middle line and coalesce. The front part of the palate is formed by the inter-maxillary bone, which carries the incisor teeth, and is the lower part of the fronto-nasal process. This coalesces with the maxillary processes on either side. The inter-maxillary comprises also the median portion of the lip and the nasal septum. The median portion of the lip should unite with the lateral portions, which cover the maxillary out-growths, and thus the upper lip is formed. When all these processes are incomplete, we have a complete cleft of the palate and double hare lip, the central bone projecting with a wide gap on either side of it. In minor degrees of deformity, single hare lip may be present of various degrees of severity, but the palate is seldom cleft, without the lip. It follows that the cleft in hare lip is nearly always to one side of the median line. A central cleft is of great rarity, and is explained by the fact that the lower end of the fronto-nasal process is sometimes deficient or bifid.

Structures divided in Operations.—In removing one-half the

lower jaw, the external incision would divide the skin and fascia, the orbicularis oris, mucous membrane, coronary and inferior labial arteries, facial artery and vein, the mental nerve and maxillary branches of the facial nerve. In clearing the exterior of the bone, the knife would divide the levator menti, the depressors of the lower lip and angle of the mouth, the dense masseter and the buccinator. It should be especially noted that the incision should not be carried so far up the bone behind as to divide the facial nerve. One of the lateral incisors is next drawn, and the bone with its dental artery and nerve divided. The structures cleared away from the inner surface of the jaw are the genio-hyo-glossus, genio-hyoideus, and digastricus, the mylo-hyoideus and sub-maxillary gland, a portion of the upper constrictor muscle, the pterygoids, and the temporal muscle, the dental artery and nerve at their entrance to the foramen, the stylo-maxillary and internal lateral ligaments. The capsular and external lateral ligaments of the articulation are also severed. By peeling the parts away from the tumour, and not using the knife too freely in the deeper dissection, much hæmorrhage can be avoided. In disarticulating the bone, great care must be taken to avoid wounding the internal maxillary artery. This is one of the most important precautions in the operation.

The incision for removing the upper jaw runs along the lower margin of the orbit, the side of the nose, and through the middle of the upper lip. It would divide skin fascia, orbicularis muscle, the levators of the alæ of the nose and upper lip, the zygomaticus minor and anterior fibres of the masseter, the infra-orbital nerve and artery. Along the side of the nose are divided the fascial structures, the small muscles of the ala and the attachments of the lateral cartilages to the bones, the twigs of the facial artery and radicles of the facial vein. In the upper lip are divided the mucous membrane, coronary artery, and orbicularis oris muscle. Numerous filaments of the facial nerve to the above-mentioned muscles are also severed. In turning the flap from the bone, much connective

tissue and the short muscles are divided, with some fibres of the buccinator. The palatal process and the horizontal plate of the palate bone are now divided; the malar process is sawn across, and the nasal process divided with forceps. In raising the soft parts from the floor of the orbit, the inferior oblique tendon might be displaced. The bone is now wrenched out, and the soft palate divided with scissors. The hæmorrhage is profuse. It comes from the superficial vessels of the face and the internal maxillary artery, the alveolar, palatal, infra-orbital, and dental branches of which are cut or torn. The nerves divided and torn are the filaments of the first and second divisions of the fifth. Some fibres of the external pterygoid and superior constrictor muscles are also detached from the tuberosity of the upper jaw.

In cutting down upon the anterior-inferior angle of the parietal bone, the knife would divide the skin and fascia, a layer of areolar tissue connected with the aponeurosis of the occipito-frontalis muscle, the temporal fascia, muscle, and peri-cranium, the superficial temporal artery, and the deep temporal arteries from the internal-maxillary, the auriculo-temporal nerve, and the temporal muscular branches from the third division of the fifth.

CHAPTER II.

THE NECK.

The prominences of surgical importance to be felt on the front part of the neck are the body of the hyoid bone, with its cornua on either side, the thyroid and cricoid cartilages. The cricoid cartilage is on a level with the sixth cervical vertebra. Here the omo-hyoideus crosses the common carotid artery; here the trachea and œsophagus commence; and against the prominent tubercle of the transverse process of the sixth cervical vertebra the carotid artery can be compressed, but not efficiently or for long. The space between the hyoid bone and the jaw is filled by the hyo-glossus, mylo-hyoid, genio-hyoid, stylo-hyoid, and digastricus muscles, with the supra-hyoid aponeurosis. The thyro-hyoid membrane and muscle occupy the space between the hyoid bone and the thyroid cartilage; and the crico-thyroid membrane and muscle, the space between the cricoid and thyroid cartilages.

The trachea recedes from the surface towards the episternal notch.

At the back of the neck you can feel the prominence of the spines of the sixth and seventh cervical vertebræ. By deep pressure the spines of the axis and intervening vertebræ can be detected, but they are never prominent. An undue prominence of the spines of any of the upper cervical vertebræ is apt to mean disease of the bones. The tubercle on the anterior aspect of the transverse process of the sixth cervical vertebra is called the carotid tubercle. The common carotid can be compressed against it. The transverse process of the

seventh cervical vertebra is developed by a separate centre. Sometimes it takes an unusual growth, and is then known as a cervical rib. This forms a hard, deeply-seated swelling in the supra-clavicular fossa, and has been known to press upon the brachial plexus, or even the main artery. The pleura will probably lie in contact with it below.

Muscles. — The sterno-mastoid muscle extends from the mastoid and occipital bones above to the clavicle and sternum below. If a knife were thrust into the neck, between the sternal and clavicular attachments of the muscle, the internal jugular vein, carotid artery, or vagus nerve might be wounded, or on the right side, the bifurcation of the innominate artery.

The surgical relations of this most important muscle are as follows:—It divides the side of the neck into two great triangles—anterior and posterior. Superficially are the integument, platysma, and superficial cervical fascia. The great auricular nerve pierces the fascia near the middle of its posterior border, and the superficialis colli nerve crosses the muscle in the same situation. The external jugular vein crosses the muscle from the angle of the jaw to the middle of the clavicle, and pierces the fascia near the posterior margin of the muscle, just above that bone. Some superficial lymphatic glands also lie over the muscle, and along its posterior border. The muscle overlies the common carotid artery, jugular vein, vagus and descendens noni nerves, with the sympathetic and cervical plexus. It also covers important groups of lymphatic glands, and a portion of the parotid gland near the skull. It overlies the sterno-clavicular articulation; and is in relation, from below upwards, with the sterno-hyoid, sterno-thyroid, omo-hyoid, digastric, levator anguli scapulæ, and splenius muscles. The scaleni muscles are also covered by it below. The anterior jugular vein passes beneath it, on its way to join the external jugular. The spinal accessory nerve pierces the anterior border of the muscle in its upper third, about an inch below the mastoid, and emerges at its posterior margin in the

middle third. The deep layer of the cervical fascia is beneath the muscle.

The prominent border of the trapezius is readily to be felt, extending from the occiput above to the clavicle below. The triangular space between the sterno-mastoideus and trapezius is occupied by the following muscles, reckoning from above downwards: — The splenius, levator anguli scapulæ, and scalenus medius. The omo-hyoid muscle crosses the posterior triangle above the clavicle. This muscle can be distinctly defined or felt in long, thin necks, by stretching the head towards the opposite side. To map its course, draw a line close above the clavicle, from the situation of the supra-scapular notch beneath the trapezius, forwards to the sterno-mastoid muscle opposite the cricoid cartilage. This line ascends but slightly. From thence draw another line, with a rapid slope upwards, to the body of the hyoid bone. The posterior belly lies beneath the trapezius and cervical fascia, and overlies the scalene muscles and the roots of the brachial plexus. Below it is the third portion of the subclavian artery. The anterior belly crosses the sheath of the carotid vessels opposite the lower border of the body of the sixth cervical vertebra, and also overlies the sterno-hyoid and sterno-thyroid muscles, and the descendens noni nerve. The muscle passes under the sterno-mastoid. A consideration of the position and relations of this muscle is thus seen to be of great surgical importance. To define the digastric muscle, draw a line from the mastoid process to the body of the hyoid bone, and another from thence to the symphysis menti. These two lines correspond in position with the anterior and posterior bellies of the muscle. The posterior belly is covered by the sterno-mastoid and splenius muscles, and the parotid gland. It overlies the external and internal carotid arteries, the internal jugular vein, and the great nerves. The tendon passes through the stylo-hyoideus. The anterior belly of the digastric is covered by the cervical fascia, and rests upon the mylo-hyoideus and hyo-glossus. It forms the lower boundary

of the sub-maxillary triangle. The sub-maxillary gland, with the facial vein and artery, are just above it, resting upon the mylo-hyoideus. Suppose a free curved incision were made just above the digastric beneath the jaw: after dividing the skin and fascia and cutaneous nerves, you would come upon the sub-maxillary, salivary, and lymphatic glands, lying upon the mylo-hyoid muscle, with the tendon of the digastric below. The facial vein crosses over the gland obliquely in its passage to the internal jugular, and the facial artery passes through the gland, giving off numerous branches. These glands are too often implicated in malignant tumours, usually secondary to like affections of the mouth and tongue. They are hard, fixed, and of the shape of a kidney potato. You will always be prepared for furious bleeding from the facial artery in their removal.

If you divide or turn aside the mylo-hyoid, you expose the hyo-glossus, and lying upon it are Wharton's duct, the gustatory nerve, and the hypo-glossal nerve. Beneath the hyo-glossus lies the lingual artery, the glosso-pharyngeal nerve, and the genio-hyo-glossus muscle. These parts are of great importance in securing the lingual arteries in the neck, in the removal of deep tumours, and in suicidal wounds. The sterno-hyoid and sterno-thyroid lie on either side of the trachea, the sterno-thyroid being nearer the middle line at the root of the neck. The edges of the sterno-thyroids are held apart in the operation of low tracheotomy.

The scalenus anticus is an important muscle in the surgical sense. Its upper attachment is to the anterior tubercles of the transverse processes of the third to the sixth cervical vertebræ, its lower to the tubercle on the first rib. The muscle is covered by the sterno-mastoid and cervical fascia, and is crossed by the omo-hyoideus and the phrenic nerve. The subclavian vein lies in front of it, the subclavian artery and the roots of the brachial plexus, with the pleura, behind it. On its inner side are the rectus capitis anticus major, the ascending cervical artery, and the internal jugular vein.

The direction of the fibres of the platysma is in a line drawn from the chin to the shoulder. In bleeding from the jugular vein, the incision should be across the fibres of this muscle. The mass of muscles at the back of the neck are as follows:—Superficially, the trapezius and splenius, next the complexus. This muscle in its turn covers the obliqui, recti postici, and posterior occipito-atloid ligament, with the vertebral artery piercing it. The trachelo-mastoid and transversalis colli lie near the middle line.

Cervical Fascia.—Much surgical importance attends a consideration of the course and attachments of this aponeurosis. Though descriptions of it somewhat vary, the more important points are as follows:—

It is attached behind to the spines of the vertebræ, and encloses the trapezius muscle, sending down septa between the subjacent muscles. It passes as a broad sheet across the posterior triangle of the neck, and splits to enclose the sterno-mastoid muscle, uniting at its anterior border, passing over the anterior triangle of the neck, and becoming continuous with the fascia of the opposite side. The part which passes above the sterno-mastoid muscle may be termed the superficial layer of the deep cervical fascia. Above, it is attached to the jaw in front, but passes over that bone behind, covering the parotid gland, to the zygoma, forming the dense and tough parotid fascia. In front, the superficial layer of the cervical fascia is attached to the body of the hyoid bone, and, as it descends, splits into two laminæ,—the superficial of which is attached to the sternum and inter-clavicular ligament, the deep to the back of the sternum, covering the sterno-hyoid and sterno-thyroid muscles. Between these layers is some loose connective tissue, occasionally a lymphatic gland, and a transverse branch connecting the anterior jugular veins.

The deeper layer of the cervical fascia sends down septa between the muscles, and, passing deeply between the depressors of the hyoid bone, invests the thyroid gland and part of the trachea, extending down into the mediastinum. Above, a

process extends from the styloid process to the angle of the jaw, separating the parotid from the sub-maxillary glands, and in this the stylo-maxillary ligament is formed. In the posterior triangle, a process of the deep layer of the cervical fascia is found, binding the tendon of the omo-hyoid muscle to the cartilage of the first rib. Extending beneath the clavicle, the fascia becomes continuous with the costo-coracoid membrane. The carotid sheath enclosing the artery, vein, and vagus nerve, is formed by the deep layer of the cervical fascia. Lastly, it is continuous with the fascia (præ-vertebral) which separates the œsophagus and pharynx from the longus colli and rectus capitis anticus muscles. This last-named lamina of fascia is intimately adherent to the carotid sheath behind, and passes over the scalene muscles along the brachial nerves and axillary vessels, forming the axillary sheath. The axillary and subclavian veins are both adherent to their fascial sheaths. The external jugular vein pierces the deep cervical fascia just above the clavicle.

Surgical Importance.—In the first place, this fascia determines the course of purulent collections in the neck. Suppose that, after scarlet fever, an acute abscess should form deep in the neck, fluctuation will not be evident; and insidious, deeply-seated destruction of parts by the burrowing pus ensues. The great vessels may even be opened. Again, abscesses are conducted by this fascia to a distance from the seat of original mischief, as from the neck into the axilla. After operation, or suicidal wounds of the neck, suppuration may extend to the mediastinum. An alveolar abscess may point and burst far down the neck. This fascia being adherent to the great veins, explains why these bleed furiously from both sides when wounded, and the risk of air entering their gaping mouths must not be overlooked. Tumours situated beneath the sterno-mastoid muscle and the deep fascia, are always difficult or impossible to thoroughly remove if malignant. With innocent growths the case is different. I have more than once seen enormous tumours in the neck and axilla shelled out with comparative ease, when once the dense fascia over them had

been freely divided. In removing tumours or enlarged glands from the neck, it is a bad practice to draw the mass forwards and cut across its deep attachments. The divided vessels then retract beneath the dense laminæ of fascia, and the most troublesome and dangerous hæmorrhage may occur. In bad burns of the neck, the subsequent contraction draws down the chin, and hideously deforms the mouth and jaw. Although the contracting bands appear to be subcutaneous, they are not really so, and when you operate you will find fascial bands extending so far down into the neck that you may be unable to follow them without dividing structures of vital importance.

Arteries.—The common carotid arteries in the neck extend from the sterno-clavicular articulations to the upper border of the thyroid cartilage, where they bifurcate. A line drawn between these points along the anterior border of the sterno-mastoid, will correspond with the course of the vessel. By deep pressure just below the cricoid cartilage, the artery may be compressed against the tubercle of the transverse process of the sixth cervical vertebra. The omo-hyoid muscles cross it just above this joint, and here also the vertebral artery enters the foramen in the transverse process of the sixth cervical vertebra. The carotid sheath is intimately connected with the deep cervical fascia. Septa are sent down between the artery, vein, and vagus nerve. On the left side, towards the root of the neck, especially note that the internal jugular vein overlaps the carotid artery. The internal jugular vein on both sides is to the outer side of the common carotid, the vagus nerve being behind and between them. The descendens noni nerve is upon the front of the carotid sheath, and the common carotid is crossed by the small artery to the sterno-mastoid, and the lingual, facial, superior, and middle thyroid veins. Internal to the vessel lie the thyroid gland and trachea, behind it the præ-vertebral muscles, the sympathetic nerve, and branches of the inferior thyroid artery.

If a ligature were placed upon the common carotid artery, the blood would reach the outside of the face and head by the

anastomosis between the superior and inferior thyroid arteries, the arteria princeps cervicis from the occipital, with the arteria profunda cervicis from the superior intercostal artery posteriorly, and the anastomosis between the facial and other branches of the external carotid, with corresponding branches of the opposite side, superiorly. Inside the cranium, the free communications through the circle of Willis usually at once restore the circulation. A line drawn from a point opposite the upper border of the thyroid cartilage to the neck of the jaw denotes the course of the external carotid artery.

This vessel is smaller than the internal carotid in the young. It is overlapped by the sterno-mastoid, and higher up by the digastric and stylo-hyoid muscles, and passes into the parotid gland which separates it from the jaw and stylo-maxillary ligament. The hypo-glossal and facial nerves cross over it. The styloid process, stylo-pharyngeus muscle, and glosso-pharyngeal nerve, separate the external carotid from the internal carotid artery and jugular vein. The internal carotid is, for the most part, deeply seated, and gives off no branches in the neck. It extends from the bifurcation of the common carotid artery to the opening in the petrous bone. At first it is covered by the sterno-mastoid, platysma, and fascia; then it passes beneath the digastric and stylo-hyoid muscles, being separated from the external carotid by the styloid process and its muscles. It is also crossed by the occipital and posterior-auricular arteries. To its inner side are the pharynx and tonsil, behind it is the rectus capitis anticus major. It is enclosed in a sheath with the internal jugular vein and vagus nerve—the vein lying to the outer side, and the nerve behind and between them.

The lingual artery arises from the external carotid opposite the greater cornu of the hyoid bone. It at first ascends, and then bends downwards, being crossed by the hypo-glossal nerve. The remaining part of the artery lies deeper, passing beneath the digastric, stylo-hyoid, and hyo-glossus muscles; it runs above the great cornu of the hyoid bone, and there ascends to terminate as the ranine. The vessel is cut down upon by a

curved incision, reaching from below the symphysis menti to near the angle of the jaw, and having its centre opposite the great cornu of the hyoid bone. This operation is needful in hæmorrhage from wounds or ulcerations of the tongue, and as a preliminary to excision of that organ. The vessel is frequently divided close to its origin in suicidal wounds of the neck.

The first part of the right subclavian artery commences behind the sterno-clavicular articulation of the right side, and ends at the inner border of the scalenus anticus muscle. The first part of the left subclavian artery passes from the arch of the aorta to the inner edge of the scalenus. The second part of the artery lies behind the scalenus anticus. The third part of the vessel, which is selected for ligature, extends from the outer border of the scalenus anticus to the outer border of the last rib. Especially remark that the artery does not arch far outwards from the sterno-mastoid. To compress it, stand behind the patient, and, letting the fingers rest upon the back of the neck, sink your thumb downwards, inwards, and backwards, catching the vessel on the rib beneath and behind the clavicular origin of the sterno-mastoid. Practise this until you can do it with ease and certainty. The first part of the subclavian artery gives the four branches—vertebral, internal mammary, thyroid axis, and superior intercostal. On the right side the superior intercostal arises from the second part of the artery. In cutting down on the third part of the artery, the head must be thrown back and the arm well depressed. Draw down the skin over the clavicle, and make an incision upon that bone carried from the clavicular origin of the mastoid, as far outwards as the obesity or muscularity of the patient may render requisite. Define the external jugular vein at the posterior margin of the sterno-mastoid, and hold it with its supra-scapular and transverse cervical branches out of the way, or divide them between ligatures, should occasion require. Cautiously cut through the deep cervical fascia, and expose the omo-hyoid. Feel for and define the scalenus anticus muscle posterior to the sterno-mastoid; behind

this, on the rib, lies the artery; in front of it, on a lower level, lies the subclavian vein.[1] In close proximity with the artery lie the cords of the brachial plexus. The cord formed by the junction of the eighth cervical and first dorsal nerve is behind and above the vessel, and is very prone to be mistaken for it, as it readily comes into view. When the artery is tied in the third part of its course, blood is carried to the upper limb by the anastomosis between the supra-scapular and transverse cervical branches of the thyroid axis with the sub-scapular branch of the axillary artery, and by the anastomosis between the thoracic and sub-scapular branches of the axillary with the intercostal branches of the internal mammary and aorta.

The vertebral artery enters the foramen in the transverse process of the sixth cervical vertebra, opposite the lower margin of the cricoid cartilage. At its origin it is situated behind the jugular vein and thoracic duct (on the left side), and between the longus colli and scalenus anticus muscles. It has been tied in this situation. The vessel comes out of its bony canal at the back of the neck, where it is contained in the triangular space, bounded by the rectus capitis posticus major and the oblique muscles. It then pierces the posterior occipito-atloid ligament, and, entering the foramen magnum, joins with its fellow of the opposite side to form the basilar.

Veins.—There are four jugular veins on each side of the neck. The external jugular commences below and behind the angle of the jaw, and usually terminates in the subclavian vein, just above the clavicle at the posterior margin of the sterno-mastoid. It is formed by the continuation of the temporo-maxillary vein joining with the posterior-auricular, and receives the occipital, posterior-external jugular, transverse cervical, and supra-scapular veins. It is provided with two pairs of incomplete valves near its termination. This vein is situated beneath the platysma, but above the cervical fascia. It pierces that structure immediately above the clavicle. A line drawn from the angle of the jaw to the middle of the clavicle

[1] In life, when this vein is engorged, I have seen it rise as high as the artery.

would define its course. In bleeding from the external jugular vein, a pad must be fixed over the vein above the clavicle, and the vessel opened in the course of the fibres of the sterno-mastoid and across the platysma. The blood may be allowed to flow through a tube, and pressure must be maintained upon the orifice when the supra-clavicular pad is being removed and the part bandaged, lest air enter the circulation.

The internal jugular vein commences outside the skull by the coalescence of the lateral and inferior petrosal sinuses. It runs down the neck on the outer side of the internal and common carotid arteries, overlapping the lower third of the left common carotid artery,[1] but being separated from the right carotid by a slight interval, in which is seen the vagus nerve. The right vein crosses the first part of the subclavian artery. This vein on both sides joins with the subclavian to form the innominate, and is provided with one pair of valves, situate about an inch from its point of embouchure. Note that the internal jugular receives all the veins which correspond to the branches of the external carotid artery, except the posterior-auricular, and sometimes the occipital. Thus it receives the facial, lingual, pharyngeal, and thyroid veins, and a large communicating branch at the commencement of the formation of the external jugular.

There are usually two anterior jugular veins, and they are connected by a transverse branch just above the clavicle, which gives rise to trouble in low tracheotomy. The anterior jugular vein commences by radicles from the sub-maxillary region at the level of the hyoid bone, and ends by passing beneath the sterno-mastoid to empty itself into the external jugular vein, just at its junction with the subclavian. It is usually destitute of valves. The thyroid veins may be divided for purposes of description into superior, middle, and inferior. They form a plexus over the front of the trachea. These

[1] It is especially important to remember this relation to the carotid, of the jugular vein on the left side, as it may be readily wounded in the operation of ligature of the artery.

veins are often perplexing in the operation of tracheotomy, especially when the patient is fat, and there is much venous congestion. In cases of operation on goitre, the radicles of the thyroid veins are enormously enlarged, and thin walled; lying as they do in the capsule of the gland, they are easily torn or wounded. If this happens, the most profuse hæmorrhage occurs. In removing a goitrous thyroid, keep clear of the capsule, and tie the vessels at each angle of the tumour.

Nerves.—The integument over the back of the neck is supplied by the internal branches of the posterior divisions of the third, fourth, and fifth cervical nerves. The cutaneous nerves of the sides and front of the neck emerge at the posterior margin of the sterno-mastoid, near its middle; the ascending filaments are the auricularis magnus and occipitalis minor; the transverse, the superficialis colli; the descending, the sternal, clavicular, and acromial branches of the cervical plexus. The small occipital nerve pierces the fascia near the cranium; the superficialis colli, at the anterior margin of the sterno-mastoid; the auricularis magnus, at the posterior margin of the muscle.

The vagus nerve runs behind and between the carotid artery and jugular vein, from the jugular foramen to the root of the neck; when, on the right side, it crosses the first part of the subclavian artery; on the left, passes between the carotid and subclavian arteries behind the left innominate vein. The superior laryngeal branch of the vagus supplies, by its external branch, the crico-thyroid muscle, by its internal branch, the mucous membrane of the larynx and aryteno-epiglottidean folds. This nerve is rarely paralysed. The recurrent laryngeal nerve supplies all the other muscles of the larynx. When it is paralysed, the corresponding vocal cord is generally seen in the position of abduction, and the voice hoarse or reduced to a whisper. When this nerve is irritated by the pressure of a growth or aneurism, fatal spasm of the intrinsic muscles of the larynx may occur. The left recurrent nerve winds round the aortic arch, and is frequently implicated in

such affections as thoracic aneurisms and tumours of the thorax or root of the neck. It may be much endangered in the removal of large goitres, and in œsophagotomy. If an adult complains of cough and hoarseness, and you find paralysis of the left recurrent nerve, the chances are that he suffers from aortic aneurism.

The hypo-glossal nerve, issuing from the cranium through the anterior condyloid foramen, courses down the neck between the internal carotid artery and the internal jugular vein, and, passing forward between these structures, loops round the occipital and external carotid arteries. It is the great motor nerve to the tongue, and likewise supplies the thyro-hyoid muscle by a special branch.

If it were divided, the tongue would be portruded towards the paralysed, and retracted into the mouth towards the sound side. Its descending branch joins with a communicating twig from the second and third cervical nerves in front of the carotid sheath, and filaments from this loop supply both bellies of the omo-hyoid and the other depressors of the hyoid bone. The glosso-pharyngeal nerve runs inwards across the internal carotid artery, lying at the lower border of the stylo-pharyngeus muscle, and terminating beneath the hyo-glossus muscle. It supplies, at its termination, filaments to the posterior third of the tongue and mucous membrane of the fauces. The spinal accessory nerve runs outwards beneath the jugular vein, and pierces the sterno-mastoid in its upper third, it then crosses the posterior triangle of the neck, and passes beneath the trapezius, which it supplies.

The phrenic nerve arises from the third and fourth cervical, about opposite the hyoid bone, runs down the neck to the sterno-clavicular articulation, and crosses the scalenus anticus muscle from without inwards into the thorax. If fracture of the spine, with lesion of the cord, occur at or above its origin, speedy death must occur. Should the lesion occur below the origin of the phrenic nerve, life may be maintained for hours by the respiratory action of the diaphragm. You will note,

too, that, in such instances, sensation is not lost over the upper and front of the chest, since the descending branches of the cervical plexus are here distributed. The sympathetic system of nerves in the neck is extensive. The upper ganglion lies opposite the transverse processes of the second and third vertebræ behind the jugular vein, the middle ganglion is about opposite the transverse process of the fifth vertebra, and the last is opposite the sixth or seventh. Filaments from the sympathetic in the neck go to form the cavernous plexus, and send twigs to the iris. Consequently, in irritation of the sympathetic in the neck, the pupil dilates, in paralysis of the sympathetic, the pupil contracts. I have more than once seen curious conditions of the pupil accompanying aneurism and malignant disease of the glands of the neck, or injury of the cervical spinal cord.

Bursæ.—Numerous bursæ have been described in the region of the neck by Calori and others. They may be proved to exist, by ordinary dissection, over the front of the thyroid cartilage, the thyroid gland, beneath the thyro-hyoid membrane, and over the vertebra prominens posteriorly. Bursal formations are stated to exist also between the trachea and arch of the aorta, between the genio-hyo-glossi muscles, and around the bellies of the digastric. It is well to remember that a cystic swelling in the neck, even of large size, may be of this nature.

Cut Throat.—Suicidal wounds in the neck are usually higher on the left than the right side, and are commonly found in the thyro-hyoid space. In a transverse wound in this situation, carried back nearly to the spine, and proving fatal from asphyxia, I found divided the skin, fascia, and anterior jugular veins, the omo-hyoid and sterno-hyoid muscles, the thyro-hyoid muscle and membrane, the pharynx and epiglottis. The superior thyroid arteries, with the lingual on one side and the facial on the other, were likewise divided. The carotids and deep jugular vein had escaped injury, as is usually the case.

Opening the Air Passages.—In order to become acquainted with the surgical anatomy of the trachea, it is well to accurately determine its superficial relations. Feel in succession the hyoid bone, the thyroid cartilage, the depression below it indicating the crico-thyroid membrane, the cricoid cartilage, and the upper margin of the sternum ; note that, by throwing the head well back, the neck becomes more prominent, and the trachea is drawn upwards from the thorax. On an average, not more than two inches of the trachea in an adult can be found in the neck, and considerably less in the child.

The crico-thyroid membrane is crossed by the small crico-thyroid arteries, and bounded by the sterno-hyoid muscles and crico-thyroid muscles on either side ; it is covered by the skin and fascia, and the operation of laryngotomy is performed through it. By keeping steadily in the middle line, and defining the landmarks, this operation is ordinarily sufficiently simple. The speed with which it can be performed renders it, generally speaking, the preferable operation to perform in cases of sudden laryngeal spasm, as from foreign body. The thyroid cartilage can be split from the laryngotomy wound upwards if needful (thyrotomy). It is recommended to open the membrane transversely, to avoid the crico-thyroid artery. The vocal cords are attached on either side of the middle line low down, the false being above the true. Tracheotomy is performed above or below the isthmus of the thyroid gland. The isthmus is said to cross the trachea opposite the third and fourth rings, but you have merely to make a round of inspection in the dissecting-room, and you will see that in hardly two subjects is this structure the same in size and position. In high tracheotomy in young children, the cricoid cartilage is often notched.

The trachea is about four and a half to five inches long, and extends from the sixth cervical vertebra, opposite the cricoid cartilage, to the fourth dorsal, opposite the junction of the manubrium and gladiolus. It is partially surrounded by sixteen to twenty cartilaginous "rings" of these, but six or

eight are found in the neck. They are incomplete behind, where the tube is somewhat flattened, and its calibre therefore is not quite round. In the child, and in adults with short, fat necks, not more than one and a half to two inches of the trachea lie in the neck, even when the head is well thrown back. In such subjects, too, the tube recedes towards the episternal notch, and may lie a full inch and a half from the surface at the root of the neck. The relations of the trachea in the neck are as follows:—In front is the integument and fascia, the isthmus of the thyroid gland, and a plexus of thyroid veins. The præ-tracheal fascia is very dense and tough, being derived from the cervical fascia. The anterior jugular veins are often connected with a large branch just above the sternum; and, in children, the left innominate vein, with large inferior thyroid veins running into it, crosses the trachea just at the episternal notch, "shewing" in the neck. This is a perilous anatomical relation for low tracheotomy in young children. On either side are the sterno-thyroids and sterno-hyoids, the lobes of the thyroid gland, and the carotid sheath, with the thyroid arteries and recurrent nerves. Behind is the œsophagus and the recurrent laryngeal nerves. In the thorax the trachea is crossed by the left innominate vein, the arch of the aorta, the left common carotid, and has anterior to it also the remains of the thymus gland. Behind it is the œsophagus. On either side of the trachea lie the pleural sacs. The innominate artery and vagus nerve are on its right side, the carotid on its left.

High tracheotomy is a safer operation than low tracheotomy, on account of the depth of the trachea at the root of the neck, and the large veins which cross it. The essential points in tracheotomy are as follows:—Keep strictly in the middle line. Draw aside with forceps or blunt hooks any large veins which may be in the way. Draw forcibly downwards the isthmus of the thyroid gland. Never open the trachea till you can clearly see two or more rings. Then pass the knife in below, and cut deliberately upwards in

the middle line. In cases when numerous and large veins cross the field of operation, it is an excellent plan to work a way through them with two pairs of spring forceps pulling them away to either side. Most errors in tracheotomy are made through the operator "losing his head," and making wild stabs at the trachea before he has properly exposed it. The principal embarrassments encountered in the operation—as hæmorrhage, and difficulty in introducing the tube—must be carefully considered and studied by the light of the more recent works on operative surgery. Operating as deliberately as circumstances will permit, and having the head held steadily, so that there is no departure from the middle line, are very essential to success.

The Thyroid Gland.—The lobes of the thyroid gland are on either side of the trachea, and are connected by the isthmus which crosses this tube at the level of the third and fourth rings. Each lobe covers the inferior horn of the thyroid cartilage above, and extends to the sixth ring of the trachea below. To the left of the middle line a process of connective tissue and, occasionally, muscle passes from the isthmus or adjacent part of the thyroid gland to the thyroid cartilage or body of the hyoid bone. From the attachments of the gland to the air tube, it follows that any tumour, solid or cystic, connected with the thyroid gland, moves markedly upwards in deglutition, a most important diagnostic point. The thyroid arteries enter the respective angles of the gland, and the large venous sinuses, found immediately beneath the capsule in cases of enlargement, terminate in the thyroid veins, which empty themselves into the internal jugular and innominate veins. The gland is covered by the cervical fascia, and overlapped by the sterno-mastoid and depressors of the hyoid bone. Behind, it reaches to the sides of the pharynx and œsophagus. This gland weighs about one ounce, but may be enormously enlarged. In the operation of extirpation of a goitre, hæmorrhage and shock are dangers much to be feared at the

time of operation, and the condition of myxœdema after.[1] The essential points in the operation are—to make very free superficial incisions, so as exactly to localise important structures; to avoid wounding the capsule of the gland, in which lie the large veins; and to secure the structures at each angle by means of ligature before dividing them. Portions of the thyroid may be found in the neck, or even under the sternum, detached from the main gland. These are termed accessory thyroids, and are sometimes converted into enormous tumours.

Tenotomy.—The sterno-mastoid is often divided just above its origin in cases of wry-neck. It is needful to avoid the external jugular vein at its posterior margin. The clavicular origin of the muscle overlies the internal jugular vein, the sternal, the carotid vessel. By keeping the muscle well on the stretch, entering a blunt-pointed tenotomy knife at a puncture made over the part to be divided, and turning its edge against the tendon close above the bone, all subjacent parts of importance should certainly be avoided. So far as safety is concerned, it is far better to divide this muscle through an open wound, whereby the parts above mentioned may be seen. The incision can afterwards be carefully sutured with horsehair.

Branchial Fistulæ and Congenital Tumours.—The neck is sometimes the seat of minute fistulous openings, lined with epithelium, and several inches in length. These more commonly occur above the clavicle, and communicate with the trachea or œsophagus. They are the remains of the branchial clefts of the fœtus, which are four in number, the first corresponding to the Eustachian tube and formation of the tympanic cavity, the remaining three to the neck between the branchial arches. They should all be closed by the eighth week, in the embryo. Involutions of epidermis, and irregular obliteration of these clefts, have also been looked

[1] Modern operators advise leaving a portion of the gland to prevent this condition.

upon, with great probability, as the cause of deeply-seated congenital watery and dermoid cysts, of which the neck is a favourite site. In connection with this subject, it may be mentioned that the thyroid gland is also developed by a diverticulum from the vertebral wall of the pharynx. In a case of large cystic goitre, which Mr. John Morgan removed, one of the main cysts communicated by a free opening with the pharynx.

Position and Relations of Sub-maxillary Gland.—The outline of the sub-maxillary gland can be seen in thin necks, when put on the stretch. The gland is of oblong form, weighs about two drachms, and is contained in the sub-maxillary triangle. It rests upon the mylo-hyoid, which separates it from the sub-lingual gland and stylo-glossus muscles. It is covered by the platysma and cervical fascia. Below is the tendon of the digastric, above, the gland rests in a depression on the inner surface of the jaw. Behind, the sub-maxillary gland is separated from the parotid by the stylo-maxillary ligament. Wharton's duct leaves the gland posteriorly, not anteriorly. It curves round the mylo-hyoid, and passes between it and the hyo-glossus, to open at the side of the frænum linguæ; its orifice being marked by a small papilla, which accustom yourself to recognise. The duct is quite two inches long, and, when obstructed, a cystic dilatation of it is found beneath the tongue, constituting one form of "ranula." Salivary calculi are sometimes found in it. The facial vein crosses the gland superficially, the facial artery, very tortuous, is usually imbedded in its substance. Numerous lymphatic glands are found in this situation, and in cases of secondary cancerous disease are often incorporated with the sub-maxillary gland.

Pharynx.—The pharynx may be regarded as a musculo-membranous bag, extending from the base of the skull to the level of the cricoid cartilage. It is nearly five inches in length, and rapidly contracts below into a funnel. The fibrous aponeurosis, forming the wall of the pharynx, is attached above

to the body of the sphenoid, petrous bone, and pharyngeal tubercle; anteriorly, to the internal pterygoid plate and the pterygo-maxillary ligament, the lower jaw, base of tongue and cornu of the thyroid cartilage. Behind, it is separated from the rectus capitis anticus by loose areolar tissue. On either side are a multitude of important structures — the styloid process and its muscles, the common and internal carotid arteries, and jugular vein, and the eighth and ninth nerves. The ascending pharyngeal artery and the sympathetic nerve are also lateral relations. The muscular wall of the pharynx, of course, consists of the three constrictors, which overlap each other from below upwards. Between the middle and inferior constrictor pass the superior laryngeal nerve and artery, between the middle and superior, the stylo-pharyngeus and glosso-pharyngeal nerve; between the superior constrictor and the petrous bone lie the levator palati muscle and the Eustachian tube. There are seven openings communicating with the pharynx — the two posterior nares, the two Eustachian tubes, the mouth, larynx, and œsophagus. In the middle line, behind, can be seen a thick band extending from the basilar process above downwards, between the recti antici muscles. Lymphoid tissue is abundant in the pharynx, and especially near the posterior nares on either side, near the Eustachian orifices. (Pharyngeal tonsil.)—This, when hypertrophied, leads to the well-known "adenoid growths." It is well to recollect that, in the fœtus, a canal extends from the roof of the pharynx to the anterior lobe of the pituitary body, which is composed of tissue closely resembling the thyroid gland. This body is occasionally the seat of dermoid tumours, arising from involuted ectoderm of the pharyngeal roof. In the loose cellular tissue, at the back of the pharynx, extravasations of blood may collect, or abscess may form in connection with caries of the vertebræ. It is also not an uncommon situation for gummata, which closely simulate more serious tumours. "Spindle-celled" sarcoma may grow from the periosteum of the bones in this region.

Lymphatics.—The lymphatics of the neck are numerous and complicated, but may be shortly described as follows :— Three groups of deep lymphatic glands are described—the sub-maxillary and supra-hyoid, the superior carotid, and inferior carotid. The deep sub-maxillary group receives the lymphatics from the sub-maxillary and sub-lingual glands, and from the floor of the mouth. These glands have free communications with the parotid lymphatics and the other deep glands. The deep superior carotid glands surround the internal carotid artery, and especially the internal jugular vein, to which they are closely adherent in malignant or scrofulous disease. They receive the lymphatics of the cranium, tongue, larynx, and pharynx. The inferior carotid group extend to the axilla and mediastinum; they receive communicating branches from the other cervical glands, superficial and deep. The chain of superficial cervical glands lies along the external jugular vein above the deep fascia. They receive lymphatics from the auricle and meatus, the mastoid and occipital glands, and the integument of the neck. A chain of them lies along the posterior margin of the sterno-mastoid. These glands are to be detected enlarged in the active stages of constitutional syphilis. In cancerous affections of the fore part of the tongue the sub-maxillary glands are affected. If the disease attacks the back part of the organ, the deep carotid glands are early and often directly implicated.

In cancer or chancre of the lower lip, the hyoid and sub-maxillary glands are enlarged. In malignant disease of the larynx and œsophagus, the deep carotid glands may be felt by careful manipulation stony, hard, and fixed. This is often a great aid to diagnosis. The supra-clavicular glands may be enlarged in malignant affections of the breast and mediastinum. Detection of them is a point of capital importance to the physician in cases of mediastinal tumour. It is often the custom among students to call enlarged glands in the neck "strumous." The truth is that they are often dependent upon some abiding source of irritation in the parts from

which they receive their lymph. Their anatomy, therefore, is of the first importance to the practical surgeon. Any hard, fixed, painful, continuously-increasing glandular tumour of the neck is likely to be cancerous, and probably also is secondary to cancer of the tongue, lips, cheek, larynx, or œsophagus. A careful inquiry into the past and present condition of these parts should not be neglected.

CHAPTER III.

THE THORAX.

Bony Framework—Sternum.—The right side of the chest is rather larger than the left.

The thoracic cavity of the female is smaller than that of the male, and the sternum is shorter, the upper ribs more moveable. The top of the manubrium is on a level with the inter-vertebral disc between the second and third dorsal vertebræ, and is distant about two and a half inches from the spine.[1] The articulation between the sternum and the xiphoid cartilage is opposite the ninth dorsal vertebra. The manubrium and the body of the sternum are un-united even late in life—the so-called "fractures" of the sternum are often really dislocations. Clefts of the sternum, or large foramina through its centre, are to be explained by the development of the bone from lateral centres, and the failure of these to coalesce in the median line. The greater part of the sternum is subcutaneous. The ensiform cartilage retires from the surface, and the hollow over it is called the scrobiculis cordis. The sternum is often the seat of gummata, of caries, and, more rarely, of tumours. The bone has been trephined for the evacuation of abscess in the interior mediastinum.

The Ribs and Cartilages.—There are twelve pairs of ribs and cartilages. The first seven ribs articulate with the sternum by means of the costal cartilages. The position of the articu-

[1] This is an average of measurement in fifteen male adult bodies. In the articulated skeleton the measurements may slightly differ.

lations of the second cartilage with the sternum is marked by a transverse ridge. The lower border of the pectoralis major is about the level of the fifth and sixth ribs. The cartilages of the sixth, seventh, eighth, and ninth ribs articulate with one another, and synovial membranes intervene. The first rib is less prominent than the others, and is comparatively seldom fractured. The seventh rib is the longest, the first the shortest. The intercostal spaces are wider in front than behind, the three upper spaces are the widest. Any rib in the middle of the series, when fractured and driven violently inwards, may wound the pleura, lung, pericardium, heart, or great vessels, or may pierce the diaphragm, and enter the liver, stomach, or spleen. On "Jubilee" day, a man in the crowd thrust a pin into the buttocks of a trooper's horse. The animal lashed out, striking his tormentor on the chest, and he died instantly. The preparation in the Museum of Charing Cross Hospital shows that a portion of the sternum has been driven into the heart and pericardium.

The muscles which principally raise the ribs are considered to be the external intercostals—the levatores costarum, the scaleni, the serratus posticus superior, the serratus magnus, and the pectorals. In expiration, less muscular action is called into play owing to the elastic resilience of the chest wall. In forced expiration, the abdominal muscles largely assist the diaphragm. Seeing the large number of muscles which directly or indirectly act upon the ribs, it is always wise to examine a patient for broken ribs in the recumbent position, relaxing the muscles as much as possible. In strapping and bandaging the chest for a detected fracture, the application should always be made during expiration. It may be difficult or impossible to certainly detect a fractured rib, since the fragments are often not separated but held together by periosteum. Feel for the crepitus in all positions of the patient, and do not neglect the use of the stethoscope.

The Dorsal Vertebræ.—There are twelve dorsal vertebræ. Their anterior surface forms part of the posterior bony wall of

the thorax. "Lateral curvature" of the spine is common here. In this disease a curious rotation of the vertebræ also occurs, which is variously, but not clearly or definitely, explained. Severe lateral curvature is found in old cases of empyema. Disease of the bones is only found as a pathological rarity in lateral curvatures. Angular curvature of the spine is usually a consequence of caries of the vertebræ; more rarely of a healed fracture, or of malignant disease of the bones. The spines of the dorsal vertebræ overlap each other from the fifth to the ninth, so that stabs in this region would not be likely to wound the cord or its membranes.

Remember that there are synovial membranes between the cartilages of the ribs (except the first) and the sternum. That of the second rib has an inter-articular ligament and two synovial membranes. These joints, as well as the inter-chondral articulations before mentioned, may be the seat of pyæmic abscess, or chronic abscess from tubercular disease, and, unless you are aware of the position of the joints, such swellings are apt to be puzzling in diagnosis.

Sterno-Clavicular Articulation. — The parts forming the sterno-clavicular joint are the sternal end of the clavicle, the sternum, and the cartilage of the first rib. The joint has two synovial membranes. The inter-articular fibro-cartilage—being attached below to the cartilage of the first rib, above to the upper border of the clavicle—mainly keeps the head of the bone in position. The rhomboid ligament, passing from the cartilage of the rib to the under surface of the clavicle, is a powerful aid in preventing upward dislocation. This joint permits of movements backwards, forwards, upwards, and downwards. It may be dislocated upwards, forwards, or backwards. The displacement is almost impossible to keep in position. I have seen two cases of spontaneous dislocation of this joint. One of these was also examined by Bryant. The sterno-clavicular joint is a favourite seat of pyæmic abscess. Parts of great importance lie behind it. If a drill be passed through the left joint, it usually strikes the com-

mencement of the left innominate vein and the carotid artery; if the right joint were perforated, the right innominate vein and the innominate artery. The pleura on both sides is close to the joint. In excision of the clavicle for tumour, these relations are anxious and embarrassing.

Muscles.—The thorax is clothed by the pectoral muscles and the serratus magnus, the trapezius, latissimus dorsi, rhomboidei, serrati postici, and deep muscles of the back—as the ilio-costalis, accessorius and cervicalis ascendens. The scapula covers the ribs from the second to the eighth. The abdominal muscles are attached extensively to the ribs below. In a muscular man, the outlines of the trapezius and latissimus dorsi can be mapped out, and the serrations of the great serratus muscle are visible. The first visible serrations correspond usually with the sixth and seventh ribs. These muscles are rarely paralysed. The latissimus is supplied by the long sub-scapular nerve from the posterior cord of the brachial plexus, the serratus magnus, by the long thoracic nerve from the fifth and sixth cervical; the trapezius, its upper part by the spinal accessory nerve, its lower by the third and fourth cervical nerves.

To map out the pectoralis major, draw a sloping line along the sternal half of the clavicle and the lateral half of the sternum, and terminate it at the cartilage of the sixth rib. Next draw two sloping lines along the borders of the muscle to the bicipital ridge of the humerus. The muscle is fan-shaped, with the corners rounded off. To map out the pectoralis minor, draw a triangle, the apex of which corresponds to the coracoid process, the base to a line drawn from the upper border of the third to the lower border of the fifth ribs near their cartilages. To delineate the trapezius, raise the arm and draw a line from the occipital protuberance to the twelfth dorsal spine; draw another sloping line from the middle of the superior curved line of the occipital bone to the posterior border of the outer third of the clavicle, and a third line curving upwards from the last dorsal spine to the root of

the spine of the scapula. If you do this on both sides, you will mark out an irregular quadrilateral figure corresponding to both the trapezii.

To mark out the latissimus dorsi, let the model stand erect, raise the arms, and throw the muscles of the back into prominence. Take the highest point on the crest of the ileum, and draw two lines from it. One should curve downwards and backwards along the ileum to the third sacral spine; the other should curve forwards and upwards, having its concavity towards the "linea alba," to the ninth rib. The spinal origin extends in a line drawn from the third sacral spine to the sixth dorsal. From the sixth dorsal spine draw the upper border of the muscle in an almost horizontal line over the inferior angle of the scapula to the incipital groove of the humerus.

The important surgical relations of the pectoralis minor are as follows:—It is covered by the pectoralis major. It overlies the ribs, intercostals, serratus magnus, second part of the axillary artery, with its thoracic branches, axillary vein, and cords of the brachial plexus. Its upper border is in relation with the costo-coracoid membrane, which covers the triangular space left between the pectoralis minor and the clavicle. The long thoracic artery is in relation with its lower border.

The fibres of the external intercostal muscles are directed downwards and forwards. They commence at the tubercles of the ribs behind, and terminate at the junction of the ribs with their cartilages in front.

The internal intercostal muscles are directed downwards and backwards; they commence at the angles of the rib behind, and are continued forward to the sternum. In the two last interspaces both muscles reach to the end of the cartilage. A stab into the chest close to the spine would therefore divide the external intercostal muscle, a wound close to the sternum would penetrate the internal intercostal muscle, a wound midway between the sternum and spine would sever both muscles.

Fascia of the Thorax.—The superficial pectoral fascia has the mammary gland slung by fibrous septa between its layers. The deep fascia covers the pectoralis major. It is attached internally to the margin of the sternum, above to the clavicle; below and externally it becomes continuous with the fascia at the side of the chest, and with the axillary fascia. The costo-coracoid membrane is a dense lamina, somewhat triangular in form. If you draw a line along the lower border of the clavicle for its outer two-thirds, this corresponds to the attachment of the costo-coracoid membrane to that bone, where it splits to enclose the sub-clavius muscle. A line drawn from the coracoid process to the first rib at its junction with the cartilage will define its lower margin. This fascia blends with the sheath of the axillary vessels and the cervical fascia above, below it is continuous with the axillary fascia. The distribution of this strong fascia explains how pus may work from the neck to the axilla, or the reverse. In traumatic aneurisms and deep abscess the pectoral muscles are pushed forwards, the strong fascia stretching across the axilla preventing swelling in this situation.

Cutaneous Nerves.—The cutaneous nerves of the thorax are mainly derived from the six upper intercostal nerves. The lateral cutaneous branches of these pierce the intercostal muscles and fascia and the serratus magnus in a line one inch behind the anterior border of the axilla. They divide into two twigs; one passes backwards over the latissimus dorsi, the other forwards over the pectoral muscle. The first intercostal nerve has no lateral branch. The second intercostal has one posterior-lateral branch (intercosto-humeral); this passes into the axilla, and is there connected with the nerve of Wrisberg, which pierces the fascia near the middle of the arm on its inner aspect. The intercostal nerves terminate close to the sternum in the anterior cutaneous nerves of the thorax. They pierce the internal intercostal, the membrane continued forward from the external intercostal, the pectoralis major and integument, supplying the skin over the mamma

and sternum. You must especially remark that the skin over the chest and shoulder is also supplied by descending branches from the third and fourth cervical nerves. In a case of fractured spine, opposite the sixth cervical vertebra, the intercostal muscles would be paralysed, and while the patient lived he would breathe by the diaphragm alone. Sensation would be maintained over the integument of the shoulder, and of the chest nearly as low as the nipple. A knowledge of the distribution of the cutaneous nerves of the thorax is of vast importance. This is one of the regions where "referred" nervous pains are so common. A man has neuralgia in the side of his chest and down the arm, he is found to have a mediastinal growth or thoracic aneurism. A delicate boy has pain and hyper-æsthesia over the lower part of his chest: these symptoms are treated as rheumatic by one doctor, as dyspeptic by another, while the friends refer to them as "growing pains." At length the case is cleared up by the discovery that one pleura is full of fluid, or that caries of the spine exists, and the disease is irritating the roots of the intercostal nerves. These are only a few examples of the importance of your having a knowledge of the distribution of the cutaneous nerves for other than examination purposes.

Lymphatics.—The pectoral glands lie along the lower border of the pectoral muscle, and discharge their lymph into the axillary glands. They receive the superficial lymphatics of the thorax and abdomen as far down as the umbilicus, and most of the lymphaties of the mamma. They may be found enlarged in cancerous or syphilitic affections of these parts, or in such skin diseases as scabies or impetigo. The umbilicus is on debatable ground between the axillary and inguinal lymphatics. I have seen a very considerable tumour form in the glands of the axilla from a small melanotic affection of the umbilicus. The superficial lymphatics of the skin of the back, from the seventh cervical vertebra to the iliac crest, empty themselves into the posterior axillary glands. The deep

lymphaties of the thorax are anterior and posterior. The former run into the glands in the anterior mediastinum; the latter into the intercostal glands which lie on each side of the spine. The deep lymphaties of the inner half of the mamma freely communicate with the anterior mediastinal lymphatic glands, which are more often involved in cases of cancer of the breast than is generally suspected.

The Mamma.—The mammary gland is enclosed between the layers of the superficial fascia, which sends numerous septa (ligamenta suspensoria) between its lobules. When these are drawn upon by the contraction of a hard cancer, puckering of the skin is produced.

The breast covers the ribs from the third to the sixth or seventh, and the nipple is usually placed in the fourth intercostal space, four inches from the mid-sternum. The nerves supplying the breast are cutaneous twigs of the intercostals from the third, fourth, and fifth. The arteries requiring ligature when the organ is removed are the intercostal twigs of the internal mammary, and the first three perforating branches of the same vessel, branches from the third, fourth, and fifth intercostal arteries, and the long thoracic branch (external mammary) of the axillary.

The principal points to attend to in the excision of the mamma are as follows:—The incisions must go far and wide of the skin over the tumour; they should be in the direction of the fibres of the pectoralis major muscle, and the lower one should be made first, to avoid the site of operation being obscured by bleeding. Having dissected the flaps thus formed from the entire gland, it should be peeled from the deep fascia by seizing its axillary margin, and detaching it towards the sternum. In every case the incision should be prolonged towards the axilla, and this cavity explored for enlarged glands, which should be removed.

Portions of the ribs are frequently excised for empyema. It is essential to work very close to the bone, peeling the tissues away from it with a raspatory before division. The

thickened pleura which remains may, in suitable cases, be cut away with curved seissors, the arteries being tied as divided.

To tap the pleura, enter your trocar in the sixth interspace, behind the mid-axillary line. This is much higher on the chest wall than you might imagine. To open the pericardium for purulent effusion, make an incision in the left fifth interspace, two inches outside the sternum. This will avoid the internal mammary artery. The bulging pericardium will be plainly deteeted, and may be cautiously punctured. Another plan is to puncture in the fifth interspaee very close to the edge of sternum.

Position of the Lungs and Pleura.—The apex of each lung rises above the clavicles for about one and a half inches. The margins of the lungs slope together, and run parallel from the lower border of the manubrium to the *fourth* cartilage. The margin of the left lung is deeply notched, to allow the heart to become superficial. The lower border of each lung slopes from the sixth cartilage to the tenth dorsal spine, posteriorly. There is but little lung behind the manubrium. The border of the right lung reaches to the median line of the sternum. To map out the lungs, therefore, draw two lines from just above the clavicles, through the sterno-clavicular joints, along the front of the manubrium ; thenee continue them parallel to each other, along the mid-sternum as far as the fourth cartilage. On the left side, continue the line with a curve from the fourth cartilage to a point in the fifth interspace three inches to the left of the sternum, and thence to the sixth cartilage. The margins of both lungs are now similar in position. Mark with your chalk in the nipple line the sixth rib, opposite the posterior-axillary line the eighth or ninth rib, opposite the scapula the tenth rib. Now draw a sloping line joining these points, and the lower margin of the lung on either side is suffieiently accurately defined. The posterior margins of the lungs can be delineated by drawing two lines from the tenth dorsal spine along the side of the vertebral eolumn as high as the seventh cervical spine. There is usually no lung opposite the

last two interspaces. The pleura overlaps the margin of the lung, especially below and on the left side where the left lung is notched for the heart. The right pleura extends to the left of the median line. Below and behind, the pleura extends to the lower margin of the last rib, and even beyond it, so that it has been inadvertently opened in cutting down upon the kidney. The line of the pleura is a good two inches below the margin of the lung, in the nipple, axillary, and scapular lines. To map out the pleura, therefore, you only have to draw a line exaggerating the outlines of the lungs, and sloping along the side of the thorax from the base of the ensiform cartilage about two and a half inches from the lower thoracic margin, back to the last dorsal vertebra.

The Trachea and Bronchi.—To map out the direction of the trachea posteriorly, draw a line from the sixth cervical spine to the lower border of the fourth dorsal vertebra. The right bronchus is about an inch long, shorter and wider than the left; it passes obliquely downwards to the level of the fifth dorsal vertebra. The left bronchus is nearly two inches long, reaching as far as the level of the lower border of the seventh dorsal vertebra. Foreign bodies usually tumble into the right bronchus. The dimple in the skin at the root of the spine of the scapula indicates the region over which you should apply the stethoscope, if you suspect pressure or occlusion of a main bronchus.

The Œsophagus.—Draw the œsophagus posteriorly, by commencing your chalk line opposite the sixth cervical spine. Incline slightly to the left at first, then to the median line opposite the fifth dorsal spine, incline it again to the left, and stop opposite the tenth dorsal vertebra. Here the tube passes through the diaphragm. This is about opposite the left seventh costal cartilage anteriorly.

The Heart and its Valves and Pericardium.—Much difference exists among authors as to the exact position of the heart and its valves. This puzzles students. It is to be explained by the fact that viscera do not occupy exactly the same

position in different individuals, and that in those who die of thoracic diseases the position of the heart is often greatly changed. Bearing these observations in mind, proceed to map out the heart as follows. Draw a slightly oblique line across the sternum, from the lower border of the right third to the left second cartilage. This line should project two inches to the left and half-an-inch to the right of the sternum. The cardiac apex should be marked in the fifth interspace, full three inches to the left of the mid-sternum. To define the right border of the heart, draw a curve from the end of the base line to the articulation of the right sixth cartilage with the sternum. This line continued onwards to the apex, crossing the lower end of the sternum above the xiphoid appendix, will correspond to the lower border of the heart. The left border is mapped by a curved line extending from the apex to the left second cartilage, well inside the nipple line.

The right auricle extends from the third to the lower border of the fifth cartilages. The left auricle is behind the second, third, and fourth cartilages. The main part of the front of the heart, formed by the right ventricle and the "conus arteriosus," is uncovered by lung. The border of the right ventricle corresponds to the lower border of the heart. The border of the left ventricle corresponds to the lower two-thirds of the left border line. The centre of the tricuspid valve is behind the sternum opposite the fourth interspace. The mitral orifice lies close to the left edge of the sternum, behind the fourth cartilage. A drill passed through the left side of the sternum, opposite the third cartilage, will generally wound the aortic valves. The pulmonary valves lie a little higher, behind the junction of the upper border of the left third cartilage with the sternum.

The outline of the normal pericardium may be roughly understood by imagining the heart to be contained in a triangle, the base of which abuts upon the diaphragm, and the apex corresponds with the position of the great vessels above the base of the heart. The base line will therefore

extend from a point in the left fifth interspace, below and external to the cardiac apex beat, to the right fifth interspace, crossing the sternum at the base of the xiphoid appendix. From the extremities of this line draw two curves (including the right and left borders of the heart) as high as the second cartilages. When the pericardium is distended, it far transgresses these limits, and may even come to press upon the venæ innominatæ, causing œdema of the arm or face.

The Great Vessels.—The upper border of the arch of the aorta is thus delineated. Commence a curved line opposite the middle of the sternum, on a level with the third cartilage; continue it upwards and to the right as high as the right second (aortic) cartilage, and across the sternum, one inch below the episternal notch; the aorta then reaches the spine, and passes along the left side of the fourth dorsal vertebra. If you draw a line from the position of the transverse arch to the right sterno-clavicular articulation, it corresponds with the position and course of the innominate artery. A line drawn to the left of the preceding, from the transverse arch to the left sterno-clavicular articulation, will indicate the course of the thoracic portion of the carotid. Draw a line from the end of the transverse arch, behind the left of the sternum, straight upwards to the clavicle, just external to the articulation, and you delineate the vertical thoracic course of the long left subclavian artery. Finally, turn your model round, and draw a line from the fourth to the twelfth dorsal vertebræ, inclining from the left to the middle line; this indicates the course of the thoracic aorta.

The internal mammary artery is marked by a line half-an-inch distant from the sternum, and extending from the first cartilage to the seventh. Below this point the vessel divides into musculo-phrenic and superior epigastric arteries.

The right aortic intercostal arteries are longer than the left, and pass over the front of the vertebral column, behind the pleura œsophagus sympathetic and vena azygos major. Each vessel ascends obliquely, from below upwards, to the angle of

the rib above, and here divides into two branches.. One continues its course along the lower border and inner surface of the rib above, the other along the upper border and inner surface of the rib below.

The relation of the structures in the intercostal spaces is from above downwards—vein, artery, nerve. In the upper spaces the nerve is above. Tapping or opening the chest should be done in front of the angles of the ribs, and in the centre of the interspace; thereby the intercostal artery is avoided. When an intercostal artery is wounded, it can be tied, should the hæmorrhage be dangerous, by resecting a portion of the corresponding rib.

The innominate veins and the superior cava are destitute of valves. The innominate veins are formed by the subclavian and internal jugular. They also receive the inferior thyroid, vertebral, and internal mammary veins. If you draw a line from the left sterno-clavicular articulation, just below the episternal notch, to the right first interspace, you mark the course of the left innominate vein. This vein is very oblique in direction, and does not cross the back of the sternum transversely, as commonly explained. Remember that it may rise into the neck and cross the trachea, especially in children. The right innominate vein passes vertically from the right sterno-clavicular joint to the first interspace. The cava extends from the first interspace on the right side to the upper border of the third cartilage, where it empties itself into the right auricle. The vena azygos major empties itself into the cava just above the pericardium.

The diaphragm rises to the fifth cartilage on the right, to the sixth on the left side. Its fibres arch upwards to those levels from the whole of the inner surface of the six lower costal cartilages.

Penetrating wounds of the thorax are dangerous and often fatal injuries. It will here be useful to point out the probable injuries which would occur from penetrating wounds in different localities—as from revolver bullets, stabs from long knives,

and the like.[1] The muscular parietes penetrated should be clear from a consideration of the preceding paragraphs.

A penetrating wound through the middle of the sternum, just below the episternal notch, would pass through or between the sternal origins of the sterno-hyoid and sterno-thyroid muscles, and wound the left innominate vein; passing above the arch of the aorta, it might penetrate the trachea, and perhaps open the œsophagus. If the weapon were broad, the innominate or carotid arteries might be divided. A wound in the right first interspace close to the sternum would wound the pleura, lung, and superior vena cava. A wound in the second right interspace would injure the pleura, lung, and cava, or, if inclined at all towards the middle line, the arch of the aorta.

A wound in the third interspace would penetrate the pleura, lung, pericardium, and superior cava. In the fourth and fifth interspaces, the pleura, lung, pericardium, and right auricle would be injured. A wound in the mid-sternum generally wounds the right pleura, and not the left. Stabs in the lower intercostal spaces pass through both layers of the pleura, through the lung, and then through the diaphragm into the abdomen. If you take the trouble to do this in the dissecting-room, you will be rather surprised to see how readily an instrument passed through the lower spaces enters the abdomen through the diaphragm. The liver on the right, and the spleen and stomach on the left sides, are thus often wounded in what seems to be a chest injury. In severe fractures of the lower ribs, the fragments of bone are often driven into the abdominal viscera, the injury being quite unsuspected.

The relations of the intra-thoracic trachea and the bronchi are as follows:—The trachea being five inches long, about three inches of it are found within the thorax. It bifurcates opposite the upper border of the fifth dorsal vertebra. In

[1] These injuries have been verified on the cadaver by thrusting long pointed needles deeply into the chest.

front of it is the arch of the aorta, the cardiac plexus, the origin of the innominate and left carotid arteries, the left innominate vein, and remains of the thymus gland. More superficially is the sternum with the origins of the sterno-hyoid and sterno-thyroid muscles. The trachea is placed between the pleuræ. The vagus nerve is on either side, with the recurrent laryngeal on the left side, and the left carotid artery. Behind is the œsophagus. The right bronchus, one inch higher than the left, is wider and shorter than it. The pulmonary artery lies below and in front. The left bronchus is nearly two inches long; it crosses over the œsophagus and descending aorta, and has the aortic arch in front of it. The pulmonary artery is above and in front. The phrenic nerves on both sides pass in front of the roots of the lungs, the vagi behind them. Numerous lymphatic glands containing pigment surround the bronchi.

The intra-thoracic œsophagus descends to the tenth dorsal vertebra. The average length being nine inches, about seven inches of the tube is within the thoracic cavity. The œsophagus has in front of it the bifurcation of the trachea, the left bronchus, and the pericardium. It is surrounded by a plexus formed by the vagi nerves, the left being in front inferiorly. The pleural sacs are on either side of it. Behind the œsophagus are the longus colli, the bodies of the dorsal vertebræ, the thoracic duct, vena azygos, right aortic intercostals, and the descending aorta as it passes through the diaphragm. The consideration of the pressure effects of aortic aneurism and the growth of thoracic tumours principally concern the physician. I would only point out that a good knowledge of the anatomy of the thorax will often ensure the diagnosis of many a puzzling case. The surgeon is often called upon to pass a bougie down the œsophagus in cases of stricture. Most strictures of this tube are cancerous, and unless the utmost care be taken, an instrument may be readily passed through the walls of the diseased œsophagus into the pericardium or pleura. Again, œsophageal stricture may be

simulated by the pressure of an aortie aneurism, and the surgeon will do well to aseertain the probable presenee or absenee of this eomplieation before he passes a bougie.

A foreign body lodged in the œsophagus low down, may ulcerate into the perieardium pleura or bronehus. I have made autopsies upon two cases of epithelioma of the œsophagus, where the uleer had eaten its way into the left bronehus. The eases were all severe and exceedingly obseure, the distressing lung symptoms that ensued masking the original evil. Foreign bodies usually pass into the right bronehus, beeause that is larger, and a more direet eontinuation of the trachea. The bronchial glands may be the seat of lymphadenoma, eausing gradual pressure and obstruction of trachea or bronehus. They may suppurate and easeate; in sueh eases, portions of easeating glands have been expeetorated, and an entire gland has been known to ulcerate into the bronehus or trachea, eausing fatal dyspnœa. The eourse of the left reeurrent nerve should ever be borne in mind. The eondition of this nerve may justly be regarded as an indication of the presenee or absenee of aneurism of the aortie areh, or intra-thoraeie tumour.

CHAPTER IV.

THE ABDOMEN.

Fasciæ.—The superficial fascia of the abdomen consists of two layers. These are inseparably blended, except in front of the belly and at the groin, where some lymphatics and the superficial epigastric and circumflex iliac arteries lie between them. The deep layer is intimately connected with the linea alba. From the symphysis pubis a strong fibrous band of it passes to the dorsum of the penis, forming the suspensory ligament. The deep layer of the superficial fascia is variously described as being attached to Poupart's ligament, or passing over it to blend with the fascia lata. At the external abdominal ring the fascia is thin and lax, and prolonged down over the cord into the scrotum (inter-columnar fascia). In the scrotum the layers of fascia unite, and become of a brown colour, from the interposition between them of unstriped muscle; they here contain no fat. This is the "dartos" of the scrotum. Over the belly the deep layer of the superficial fascia, containing much yellow elastic tissue, corresponds to the tunica abdominalis of the ox. In cases of extravasation of urine, gas and fluid will readily pass from the scrotum to the abdominal wall along the spermatic cord, beneath this fascia.

The transversalis fascia is white in colour, and lines the abdominal cavity internally between the muscular parietes and the peritoneum. It is peculiarly distinct in the lower part, and is separated from the peritoneum by a quantity of areolar tissue and fat, which varies with the obesity of the individual. Above, it becomes thin and indistinct where

it lines the under surface of the diaphragm. Below, it is attached to the inner lip of the crest of the ilium, and the outer two-thirds of Poupart's ligament blending with the iliac fascia. Where the femoral vessels enter the thigh, it passes under the ligament in front of them, forming the front wall of the femoral sheath. Internal to the femoral vessels, it is attached to the spine and ileo-pectineal line of the pubes behind the conjoined tendon. Those fibres which arch over the vessels, beneath Poupart's ligament, to be attached to the pubic crest and pectineal line, are termed the deep crural arch. Laterally the transversalis fascia becomes continuous with the anterior lamella of the lumbar fascia covering the quadratus lumborum. The internal abdominal ring is an oval opening in the transversalis fascia, covered over by the infundibuliform fascia.[1]

The iliac fascia covers the iliacus and psoas muscles. Above, it is attached to the ligamentum arcuatum internum, internally to the margins of the vertebræ and inter-vertebral substance. Below, it is attached to the crest of the ilium, Poupart's ligament, and the brim of the true pelvis; behind the femoral vessels it passes into the thigh, forming the back of the femoral sheath, and blending with the pubic portion of the fascia lata. Externally, it is continuous with the anterior lamella of the lumbar fascia covering the quadratus lumborum. When pus accumulates behind this fascia it is prevented from coming forwards, and passes down into the thigh, pointing at the inner side of the vessels.

Muscles.—The muscles which form the abdominal wall anteriorly are the obliqui, the transversales abdominis, the recti, and the pyramidales muscles. Laterally and behind are the latissimus dorsi and quadratus lumborum, with the internal oblique and the lumbar aponeurosis. The lower end of the rectus corresponds to the crest and front of the pubes, the upper end to the fifth, sixth, and seventh

1 These structures will be more particularly referred to when treating of hernia.

cartilages. If you drive a knife into the belly, through the lower third of one rectus muscle, you perforate skin and fascia, the tendinous aponeurosis of the external oblique, internal oblique, and transversalis abdominis. The rectus and transversalis fascia would next be divided; the latter structure separates the rectus from the peritoneum, the three broad abdominal muscular aponeuroses sweeping in front of the lower fourth of the rectus. A penetrating wound in the middle of the course of the rectus would perforate the skin and fascia, the tendinous expansion of the external oblique, the anterior lamella of the internal oblique, the rectus, the posterior lamella of the internal oblique, the aponeurosis of the transversalis abdominis, transversalis fascia, and the peritoneum. The internal oblique splits to enclose the rectus. The linea semilunaris is opposite the point of splitting of this muscle, and extends from the seventh rib to the symphysis pubes along the outer edge of the rectus abdominis. The gall bladder lies about opposite the juncture of the right linea semilunaris with the ninth cartilage. The lineæ transversæ are tendinous intersections of the rectus muscle. Usually, there are two above and one opposite the umbilicus. Abscesses and hæmatomata may be found under these tendinous structures, and fatty tumours also, or protrusions of omentum.

Petit's Triangle. — Petit's triangle is an irregular space above the highest part of the iliac crest. Its base corresponds to the crest of the ilium, its anterior margin to the free posterior border of the external oblique, its posterior to the anterior border of the latissimus dorsi. In its floor is the quadratus lumborum and lumbar fascia. Here a lumbar abscess may "point" or a lumbar hernia form.

The quadratus lumborum muscle is irregularly quadrilateral in shape. Its lower origin corresponds to the inner two inches of the iliac crest, and the lower transverse processes of the lumbar vertebræ and adjacent ligaments. Its upper attachment is to the lower border of the last rib and

the upper lumbar transverse processes. This important muscle is in relation anteriorly with the anterior lamella of the lumbar fascia, the ilio-hypogastric and ilio-inguinal nerves, the psoas, and kidney. The colon should lie just in front of its outer border. Behind it is the middle lamella of the lumbar fascia, and the erector spinæ muscle. This muscle receives nervous twigs from the lumbar nerves, and the last dorsal nerve descends in its substance. It is likely that abscesses sometimes work their way through the muscle along the course of the nerves.

The vessels of the abdominal wall are as follows:—Branches from the lumbar and three lower intercostal arteries run between the abdominal muscles, and anastomose with the superior epigastric above and the deep epigastric below. The deep circumflex iliac sends a large branch ascending between the transversalis and internal oblique, opposite the highest point of the crest of the ilium. This branch may be divided in a deep or incautious incision to open a lumbar abscess. The deep epigastric artery is mapped out by a line drawn from the middle third Poupart's ligament to the edge of the rectus, in the direction of the umbilicus. Remember, it lies on the inner side of the deep inguinal ring. The triangular space bounded externally by the epigastric artery, internally by the edge of the rectus, and below by Poupart's ligament, is called Hesselbach's triangle. The umbilicus is surrounded by a fibrous ring formed by the linea alba. Hernia in the child occurs at the umbilicus, in the adult above or below it. The round ligament of the liver, containing the obliterated umbilical vein, extends from it above, and the obliterated hypogastric arteries and urachus below. Sometimes the umbilicus is connected with the ileum by the vitello-intestinal duct (Meckel's diverticulum), and this may be the cause of intestinal strangulation. The allantois, remaining patent below, forms the urinary bladder. It is closed above, forming the urachus. Should the urachus remain patent, urine may escape from the umbilicus.

Nerves.—The six lower intercostal nerves supply the integument of the abdomen. The lateral cutaneous branches pierce the external oblique and fascia in a line with the angles of the ribs. The posterior filaments are reflected over the latissimus dorsi muscle, the anterior filaments pass over the external oblique. The lower intercostal nerves terminate by forming the anterior cutaneous nerves of the abdominal wall; they pierce the fascia close to the linea alba.

The ilio-inguinal nerve pierces the fascia at the external abdominal ring, the hypogastric branch of the ilio-hypogastric nerve becomes cutaneous just above the ring. In caries or tumours of the spine, and in aneurism irritating the spinal nerves near their roots, pain is often referred to the cutaneous nerves above described. In children such cases are peculiarly often mistaken for abdominal disease. The "belly-ache" of caries of the spine is well known to practical surgeons.

Lymphatics.—The superficial lymphatics of the abdomen above the umbilicus enter the axillary glands; those below the umbilicus enter the inguinal glands. The umbilicus being on "debatable" ground may, if affected by chancre, cancer, or eczema, cause enlargements of both groups of glands. Over the lower part of the dorsal region the lymphatics of the skin may pass upwards to the axillary, or forward to the inguinal glands. The superficial inguinal glands are divided into a superior and inferior group. The latter are below Poupart's ligament, and vertical in arrangement; they will be noticed under the name of femoral glands, by which they are generally known. The superior inguinal glands are arranged horizontally along and above Poupart's ligament. They receive lymph from the lower abdominal wall, integument of the buttock, perineum, scrotum, penis, and lining membrane of the urethra in its anterior two-thirds. They are often enlarged, and a careful search must be made of these regions before the cause is discoverable. It may be a few pediculi concealed among the pubic hairs, a gonorrhœa, a boil on the buttock, or a venereal sore on the penis.

Regions of the Abdomen.—Define the right and left hypochondriac regions, and the epigastric region between them. Define the right and left lumbar, right and left inguinal, umbilical and hypogastric regions. The vertical lines marking out these regions are drawn from the costal cartilage of the eighth rib to the middle of Poupart's ligament. The transverse lines are drawn round the body opposite the ninth cartilage and iliac crests respectively. You are recommended to observe in the post-mortem room the structures contained in each of the regions. Then look at the subject from a practical point of view. A man is stabbed in the left hypochondriac region. The knife may penetrate the stomach and wound the left lobe of the liver. The splenic flexure of the colon, the spleen, kidney, and tail of the pancreas may possibly be injured. The splenic artery, or one of its large branches, may readily be divided. Thus a knowledge of these regions is of importance in considering the possible effects of a penetrating wound. In the diagnosis of abdominal tumours, the first thought of a practical physician is what viscus or viscera lie in the region he is investigating.

To map out the position of the abdominal contents is of the first importance. To aid the student the following points are useful :—

The umbilicus lies a full inch above a line drawn from one iliac crest to the other. If you pass a long needle straight through the navel to the spine, it generally strikes the lower border of the third lumbar vertebra. The aorta enters the abdomen opposite the last dorsal vertebra, and terminates three-quarters of an inch below and to the left of the umbilicus, opposite the left side of the fourth lumbar vertebra. The last dorsal vertebra lies full five inches above the umbilicus, but below the end of the xiphoid cartilage.

Stomach.—To map out the stomach, imagine the viscus to be moderately distended, for, when empty, it retires beneath the liver and is hard to delineate. Mark the position of the cardiac orifice over the left seventh costal cartilage; this is

nearly opposite the ninth dorsal vertebra. Make another mark on the abdominal wall two and a half inches to the right of the middle line, and three inches below the xiphoid cartilage. The pylorus is about in this situation, but is extremely moveable, according to the distension of the stomach. It usually corresponds with the ninth costal cartilage in front, the twelfth dorsal spine behind.

Bearing in mind the anatomical shape of the stomach, you can easily draw the lesser curvature between these points, and the greater curvature also. The fundus and main bulk of the stomach are almost entirely to the left of the median line, the viscus has even been opened in the operation for colotomy in the left lumbar region. The fundus rises well under the left ribs, as high as the sixth costo-chondral joint; in full distension, the stomach heaves up the apex of the heart. The usual inaccuracies committed in delineating the stomach are as follows:—The viscus is marked too horizontally—students forget that it lies in a very oblique position. The greater curvature and fundus are not marked high enough on the left side. The lesser curvature is too much curved and too horizontal. In gastrostomy, when the stomach is shrunken and empty, it is often difficult to recognise it. The omentum dependent from its lower border is an important guide, and so is the presence of the gastro-epiploic artery on the greater curvature. The stomach is in relation in front, with the left lobe of the liver, and, when distended with the abdominal wall, to a variable extent. Behind it lies, upon the ascending layer of the transverse mesocolon, the pancreas, spleen, left kidney, and supra-renal capsule. Still more posteriorly are the aorta, vena cava, and cœliac axis, with the solar plexus. Its left border is closely connected with the spleen by the gastro-splenic omentum. The viscus is everywhere covered by peritoneum, except posteriorly at the entrance of the œsophagus. It is not sacculated by longitudinal muscular bands like the colon, so that these two structures should never be confounded.

Liver.—To map out the upper margin of the liver, mark the following points :—The base of the ensiform appendix, the fifth rib in the right nipple line, the eighth in the axillary line, the tenth dorsal spine behind. Remember that the left lobe of the liver projects quite two inches to the left of the sternum, and overlaps the stomach. Now draw a curved line from below the left seventh cartilage through the points above mentioned, and you have a sufficiently accurate representation of the upper margin of the liver. The lower margin of the liver is delineated by continuing the curved line from left to right across the middle line, full three inches below the ensiform, to the right ninth cartilage; and from thence, close under the lower margin of the right lower ribs, to the spine. The left lobe of the liver in the infant fills the left hypochondrium.

Just below the ninth right cartilage is a depression where the linea semilunaris joins the ribs; the gall-bladder lies here, and can be depicted on the surface. Refresh your recollection by going into the post-mortem room and glancing at the left lobe of the liver, and the shape and position of the gall-bladder. By recollecting the anatomical shape of the liver, you will then easily sketch it out. The arch of the diaphragm corresponds in direction with the upper border of the liver during expiration, in inspiration it descends for about two inches. Thus, if you can delineate the upper margin of the liver, you can mark out the arch of the diaphragm during expiration. On the left side, the arch of the diaphragm rises only to the sixth rib in the nipple line.

Kidneys.—Much difficulty is often experienced by students in depicting the position of these organs : this arises from the fact that they will not carefully observe the position of the kidneys *in situ*. Recollect these points. The lower border of the right kidney lies lower than the left. The lower border of the right kidney is scarcely on a level with the umbilicus. The kidneys reach much higher, therefore, than is generally thought. Indeed, the upper part of these organs is sheltered by the lower ribs. The renal vessels are about two and a half

inches long, the right artery is a little longer than the left. The pelvis of the kidney is therefore about two inches from the median line. On the left side the pelvis of the kidney is opposite the first lumbar spine, while the upper end of the left kidney is opposite the eleventh dorsal spine. Remember, then, (1) that the pelvis of the kidney is two inches from the median line, and about three and a half inches above the umbilicus; (2) that the lower end of the right organ reaches to the level of the umbilicus, and that this is half-an-inch lower than the left; (3) that the organs lie obliquely, their upper ends converging, their lower diverging. If you are acquainted with the size and shape of adult kidneys, you can now easily depict them on the abdominal wall. The kidneys are covered by peritoneum only on their anterior surface. Their posterior surface is in relation with the diaphragm, psoas, anterior layer of lumbar fascia, and quadratus lumborum; the organs are here surrounded by loose fat, in which collections of blood or pus are apt to form. The anterior surface of the right kidney is covered by the liver, colon, and duodenum, the anterior surface of the left kidney by the stomach, colon, and tail of the pancreas. The kidneys are surmounted by the supra-renal capsules, and lie in contact with the diaphragm. Renal or peri-renal abscess may burst into the colon or stomach. Rupture or severe bruise of the kidney is a common complication of fracture of the dorsal spine. The main characteristic of a "renal tumour," next to its situation, is the presence of resonant intestine in front of it, showing that it originates behind the peritoneum. Posteriorly, the guide to the hilus of the kidney is a point two inches from the middle line, and opposite the first lumbar spine. The oblique position of the kidneys is hardly to be fully appreciated, unless you verify it by inspection in a recent body. To delineate the kidneys posteriorly, the method of Morris is recommended. A line is drawn parallel to the spine and one inch distant from it, from the lower edge of the eleventh dorsal spine above to the lower edge of the third lumbar spine below. Two lines are drawn

outwards from the extremities of the vertical line for two and three-quarter inches. The parallelogram is completed, and the kidney lies within it.

Ureter.—The ureters are about sixteen inches long, and of the diameter of a quill. The abdominal portion of them extends from the point above mentioned, as indicating the hilus of the kidney, along either side of the spine, to an inch below the umbilicus.

Spleen.—The spleen lies in the left hypochondrium, behind the ninth, tenth, and eleventh ribs and the diaphragm. It is very oblique in direction, following the slope of the tenth rib. Draw its concave upper border from the ninth rib in the mid-axillary line posteriorly, to a point about two inches from the middle line of the abdomen anteriorly. Its convex lower border corresponds to the tenth rib. A penetrating wound between the ninth and tenth ribs in the right axillary line would pass through the lung and diaphragm into the spleen.

Pancreas.—The pancreas occupies three regions of the abdomen. The tail of it lies over the front of the left kidney, and touches the spleen in the left hypochondriac region. The head lies in the right hypochondrium, embraced by the duodenum. The body crosses the first lumbar vertebræ at a point full three inches above the umbilicus, through the epigastric region. In a well-made adult the pancreas would be about eight inches long, and one and a half in breadth. By remembering its breadth, shape, and length, and the point where it crosses the middle line, you can easily sketch its outline.

Duodenum.—The transverse part of the duodenum crosses the spine obliquely from the right side of the third lumbar to the left side of the second lumbar vertebra. A line directed from a point three inches to the right of the umbilicus, to a point two inches to the left and above it, will about indicate the transverse duodenum. This line will be about five inches long, and will cross the spine about an inch above the umbilicus, ascending from right to left. In rupture of

intestine from violence, the lesion will often be about this situation.

Colon.—The cæcum lies in the iliac fossa. The ilio-cæcal valve is in a line drawn horizontally inwards from the anterior superior spine for about three inches from that point. The colon ascends in a line drawn upwards, well back in the right lumbar and hypochondriac regions, as high as the ninth rib in front of the right kidney. Thence the transverse colon descends nearly to the level of the umbilicus, crossing below the greater curvature of the stomach. Towards the left, the transverse colon ascends to form the splenic flexure, which lies under the eighth rib higher than the hepatic flexure. From here the descending colon passes down the left loin, well back to the pelvic brim. The narrowest part of the colon is the point where it terminates in the sigmoid. Here malignant disease is common. The large intestine is about five feet in length, and is recognised by the longitudinal muscular bands upon its surface, its sacculation, and the presence of "appendices epiploicæ" dependent from it. The colon may be found in abnormal situations—a matter of great importance in operations.[1] The cæcum and ascending colon may be covered by peritoneum in front and at the sides only. In most cases the cæcum and ascending colon are quite surrounded, the peritoneum being reflected to form a meso-cæcum and meso-colon, respectively. The descending colon is nearly always destitute of peritoneum posteriorly. In left lumbar colotomy the colon is opened close to the splenic flexure. The vermiform appendix is surrounded by peritoneum which forms a small mesentery. It is frequently the seat of ulceration and perforation.

Arteries.—To delineate the aorta, draw a line from the middle line of the body, five and a half inches above the umbilicus, to a point an inch below and to the left of it. This line will pass from the front of the last dorsal vertebra to the left side of the disc between the fourth and fifth lumbar vertebræ. An abdominal tourniquet is placed over the latter

[1] See a paper by Lockwood, *St. Bart. Hosp. Rep.* vol. xix.

point. Draw two curved lines from the point of bifurcation of the aorta to the centre of Poupart's ligament. These will represent the course of the common and external iliac vessels. The average length of the common iliac arteries occupies the first two inches of these lines. For practical purposes remember the following points. The aorta enters the abdomen about five and a half to six inches above the umbilicus. The cœliac axis comes off about four and a half inches above the umbilicus, and the superior mesenteric immediately below the cœliac axis. The renal vessels take origin from the aorta, about three inches above the umbilicus, immediately below the pancreas.

Veins.—Mark the cava inferior in blue chalk by drawing a line from a point one inch and a half to the right and below the umbilicus upwards, along the right of the median line to the level of the right sixth costal cartilage. The right and left common iliac veins pass beneath the right common iliac artery. The common and external iliac veins on both sides course down on the inner side of their respective arteries. It is a good exercise to draw the iliac arteries in red chalk, the veins in blue.

Operations.—It is not here proposed to describe all the operations on the abdomen and its contents, which must be studied in proper treatises. I merely wish to illustrate how essential a knowledge of anatomy is to their selection and performance. Take the case of a curved incision above Poupart's ligament, reaching from the position of the iliac artery to a point one inch inside the anterior-superior spine. Such an incision would be made to reach and ligature the external iliac artery, or to open a deep abscess. After dividing the skin and fascia, the external oblique will be exposed. It is tendinous here, and its fibres run downwards and inwards. The internal oblique is muscular in this situation, its fibres run forwards and upwards; the transversalis abdominis is also muscular, its fibres passing transversely. Beneath this is the white transversalis fascia, separated from the peritoneum

by some loose connective tissue. The outer surface of the peritoneum is rough and shaggy. A knowledge of the appearance of these structures will enable a surgeon to confidently divide them layer after layer with a knife, until the white transversalis fascia is exposed. The director and fingers of the operator are not needed in dividing the abdominal wall.

In the operation of inguinal colotomy a knowledge of the above anatomical points is of the first importance. Take the operation of left lumbar colotomy. A firm pillow being placed under the right flank, the left lumbar region is rendered tense and prominent. An oblique incision, about three inches in length, is made parallel with the last rib, midway between the rib and the ileum, having its centre in a vertical line drawn from a point just behind the highest part of the iliac crest. The structures divided are as follows: the skin, fascia, latissimus dorsi, and a few fibres of the external oblique muscles, the internal oblique in a muscular subject, and the lumbar aponeurosis. This may be regarded as the attachment of the transversalis muscle to the vertebræ. The quadratus lumborum is usually notched. The colon lies in front of the kidney at the outer border of the erector spinæ. The gut is sacculated, and has three longitudinal bands of muscular fibres of which you recognise the posterior. This is not a narrow rounded cord, but flattened and broad. The detection of a longitudinal band makes you absolutely certain that you are dealing with large intestine. The colon is usually opened near the splenic flexure much higher than is supposed. No vessels of importance are wounded. The deeper parts of the incision should be of the same extent as the superficial.

The pedicle of a renal tumour contains the renal vessels and sympathetic nerves. Some operators tie in the ureter, others bring it out through the wound. If the vessels are tied separately, secure the artery first.

In removing the spleen, the pedicle would contain the

splenic artery and vein, a double fold of peritoneum, and the sympathetic plexus; the gastro-splenic omentum would have to be divided, and also the suspensory ligament of the spleen.

Paracentesis is performed in the linea alba as a rule. If there is resonance over the middle line, then you must tap towards the flank where dulness exists. Before tapping, ascertain that there is absolute dulness, and that the bladder is completely empty.

CHAPTER V.

THE ISCHIO-RECTAL REGION, PERINEUM AND PELVIS.

Ischio-rectal Fossa.—If you introduce a knife by the side of the rectum, as in the opening of an abscess, it enters the ischio-rectal fossa. Cutting inwards, you would wound the levator ani and rectum with its sphincters; outwards, the knife would divide the obturator fascia and obturator internus muscle, and the internal pudic vessels and nerve on the inner surface of the tuberosity of the ischium. Carrying the incision backwards, the gluteus maximus and great sacro-sciatic ligament would be cut, with the inferior hæmorrhoidal vessels; cutting forwards, the transverse perineal muscle and base of the triangular ligament are divided. Abscess is common here, but need not always be connected with rectal mischief. Caries of the sacrum may closely simulate an ordinary "fistula in ano."

The perineum in the male is the space between the coccyx behind and the pubic arch in front. An imaginary line drawn transverse, anterior to the tuberosities, divides this space into the urethral part and the anal part. The latter is often termed the ischio-rectal region. On either side of the perineum you can make out the rami of the pubes and ischia; behind, by deep pressure, you define the edge of the gluteus maximus and great sacro-sciatic ligament. A knife introduced about one and a half inches in front of the anus in the middle line, would enter the membranous urethra where it comes through the triangular ligament; the bulb of the urethra

would also likely be wounded, unless the scrotum and penis were well drawn upwards. The incision for lateral lithotomy is variously described. Mark it by an oblique line, drawn from a point one inch in front of the anus downwards to the left, towards the tuberosity of the ischium. One of the best living lithotomists makes this external incision full three inches long. A knife carried in this direction into the bladder would successively divide the skin and both layers of the superficial perineal fascia, the superficial perineal vessels and nerves, the transverse perineal muscle, vessels and nerves, the anterior layer of the triangular ligament, the compressor urethræ muscle, membranous urethra, prostate, prostatic capsule, levator prostatæ muscle, and a plexus of veins. The incision carried too far forwards may wound the artery of the bulb; too far outwards, the pudic artery; too far backwards and inwards, the rectum.

Fasciæ.—The perineal fascia consists of two distinct layers, each of them double. These are termed the superficial fascia (fascia of Colle's), and the deep fascia or triangular ligament. These aponeurotic structures are continuous behind the transversus perinei muscle, the deep layer of the superficial fascia being there continuous with the superficial layer of the deep fascia. The superficial layer of the superficial fascia is continuous with the dartos of the scrotum and fascia of the abdomen and thighs. The deep layer of the superficial fascia is attached on either side to the rami of the pubes and ischium; behind is continuous with the deep fascia, and in front is continuous with the dartos and abdominal fascia. The triangular ligament or deep perineal fascia is dense and strong, and closes the space between the two pubic bones anteriorly, being perforated by the membranous urethra in the male, and the urethra and vagina in the female. The anterior layer, or superficial layer of the deep perineal fascia, is attached to the rami of the pubes and ischium on either side, to the arch of the pubes and sub-pubic ligament above, and, behind, blends with the deep layer of the superficial

fascia. The posterior layer of the triangular ligament, or deep layer of the deep perineal fascia, is attached on either side to the rami of the pubes and ischium in front, and above to the back of the pubes; behind, it blends with the anterior layer. This fascia is separated from the recto-vesical fascia by the anterior fibres of the levator ani muscle.[1]

The apex of the prostate gland rests upon the pelvic surface of the triangular ligament, and the membranous urethra perforates its posterior layer. In extravasation of urine, the fluid forces its way between the superficial fascia and the anterior layer of the triangular ligament, or between the deep layer of the superficial, and the superficial layer of the deep, perineal fascia. It is prevented from passing backwards, or into the thighs, by the arrangement just mentioned, and consequently passes upwards over the abdominal wall and into the scrotum and penis. In perineal abscess, the pus is so bound down by these dense fasciæ that fluctuation is seldom perceived, a hard painful lump marking the affection, which should be promptly dealt with by incision.

Arteries.—The artery that especially concerns us in this region is the internal pudic. Taking its origin from the anterior division of the internal iliac, the vessel leaves the pelvis by the great sciatic notch below the pyriformis muscle, and enters it again through the lesser sciatic foramen. The artery here rests upon the external surface spine of the ischium. It now courses along the outer wall of the ischio-rectal fossa, lying inside the tuberosity of the ischium, and being enclosed in a sheath of fascia. It next perforates the posterior layer of the triangular ligament, and where it lies—between the layers of this fascia—gives off the artery to the bulb. The artery pierces the anterior layer of the triangular ligament, and divides into the artery of the dorsum of the penis, and the artery to the corpus cavernosum. Besides the

[1] The posterior layer of the triangular ligament blends inseparably with the parietal pelvic fascia. Some authors consider that this layer of the pelvic triangular ligament is really formed by the pelvic fascia.

branches referred to, the internal pudic gives origin to the transverse and superficial perineal vessels, and the inferior hæmorrhoidal in the ischio-rectal fossa. Its surgical importance is great. Should the artery take an abnormal course, it may be wounded in lateral lithotomy. Dangerous bleeding may occur in the same operation from cutting a large branch of this vessel. The artery may be accidentally wounded by a deep stab in the buttock, as it crosses the ischial spine. Its terminal branches require ligature in amputation of the penis. By its anastomosis with the superficial external pudic twig of the femoral artery, it assists in carrying on the circulation to the lower limb after ligature of the iliac vessels. The artery of the bulb is likely to be wounded if the incision for lithotomy is carried too far forwards, and the scrotum is not drawn up.

Nerves.—The cutaneous nerves of the perineum are twigs from the internal pudic and pudendal branch of the small sciatic. In affections of the bladder, prostate, or kidneys, or in deeply-seated carious or cancerous affections of the pelvic bones, pains of great severity may be experienced in these parts. In the skin, at the margin of the anus, ramify small cutaneous nerves from the fourth sacral and the pudic. The plentiful nerve-supply of this region explains the violent "neuralgic" pains felt, about the thighs and buttocks, by patients who suffer from rectal fissure.

Urethra.—The average length of the male urethra is from eight to nine inches. Its narrowest part is the meatus urinarius, and next in order the membranous urethra. Its widest part is in the prostatic urethra, and just behind the meatus, in the dilated fossa navicularis. In the prostatic urethra the longest diameter is from side to side; in the membranous and spongy parts of the canal a cross section shows a transverse slit; in the spongy urethra near the glans the long diameter is vertical. The average lengths of the different parts of the urethra are as follows: the prostatic urethra one inch and a quarter, the membranous urethra three-quarters of an inch,

the spongy portion, about six inches. The urethra has a muscular coat, through its whole extent, lying beneath the mucous membrane, the inner fibres being longitudinal, the outer transverse. These are continued backwards over the bladder and prostate. The exact relations of the membranous urethra are of extreme importance to practical surgeons. This part of the canal is three-quarters of an inch in length along its upper, half-an-inch along its lower surface, owing to the projection backwards of the bulb.[1] It is placed about half-an-inch below the pubic arch and sub-pubic ligament. The dorsal vessels and nerves of the penis also pass above it. The lower surface of the membranous urethra is separated from the rectum by a slight interval, and is turned towards the perineum and the point of junction of the transverse perineal muscles. It is surrounded by the compressor urethræ muscle, and lies between the two layers of the deep perineal fascia or triangular ligament, which it successively perforates. Cowper's glands and their ducts are found on either side of the membranous urethra, but their ducts open into the spongy part of the canal. The accelerator urinæ muscle is superficial to the deep perineal fascia, and surrounds the bulb.

If the male urethra is laid open in its whole extent, and examined from before backwards, we find the following points of importance:—Lacunæ or pouches in the mucous membrane, especially along the floor of the urethra and in the bulbous portion. A large pouch exists in the roof of the urethra near its orifice. Consequently, the point of a catheter is directed downwards on its introduction. On the floor of the bulbous urethra are the two small orifices of Cowper's glands. On the floor of the prostatic urethra is the elevated "verumontanum." On either side and behind it are the orifices of the prostatic ducts. The seminal ducts open by slit-like orifices in the recess in front of the verumontanum, termed the sinus pocularis.

[1] The bulb is in front of the triangular ligament, and does not cover the membranous urethra, which is between its layers.

Practical Points.—When violence is inflicted on the perineum, the membranous urethra is apt to be jammed against the sub-pubic arch and sub-pubic ligament, and become lacerated. Organic stricture from injury or urethral disease usually affects the membranous urethra, or rather that part of it which joins the spongy portion at the anterior layer of the triangular ligament. The membranous urethra is the situation, also, where a catheter generally "hitches," and at the moment of its approach to this part of the canal, the handle should be depressed between the thighs of the patient. Stricture never occurs in the prostatic urethra. Obstruction often exists there from enlargement of the middle part of the gland, which forms a projection bulging upwards on the floor of this part of the passage. In passing a catheter in a case of "enlarged prostate," the following axioms may be borne in mind:—Keep strictly in the middle line; keep the instrument in contact with the roof of the urethra; depress the handle considerably; use the utmost gentleness and caution; aid the passage of the instrument over the obstruction by inserting the finger into the rectum and tilting it upwards, while the handle is depressed.

The common causes of extravasation of urine are laceration of the urethra, ulceration and leakage behind an old stricture, or about an impacted urethral calculus. In either case, a hard, painful lump (urinary abscess) is found in the perineum; and if this is not soon opened, the fluid is pumped between the deep and superficial fasciæ. It cannot get backwards because of the attachments of the fasciæ to each other round the transverse perineal muscle. The connections of the fascia with the rami of the pubes and ischium prevent it passing into the thighs; so it passes forwards into the scrotum and penis beneath the dartos, and thence up upon the abdominal wall between the external oblique and the deep layer of superficial fascia of the abdomen. The connection of this with the ligament of Poupart prevents the urine passing into the thighs, but in bad cases it may spread over the entire

belly. A common mistake in the treatment of this affection is to incise the swollen parts, and leave the perineum alone—a grave and dangerous error. A staff should be passed, and the perineum freely opened in the middle line, to allow of drainage in a dependent position, the other swollen parts being secondarily dealt with.

Pelvis.—Define the following bony points :—The anterior-superior spine of the ilium, the highest part of the iliac crest, the posterior-superior spine, the spine of the pubes. The importance of the anterior-superior spine, in measurements of the lower extremity, is dealt with in the chapter relating to the region of the groin and buttock.

The femoral artery lies half-way between the anterior-superior spine of the ilium and the symphysis pubis. In supposed fracture of the pelvis, by pressing on the spines of the ilia, crepitus may be detected. Poupart's ligament is attached to the anterior-superior spine, and the sartorius muscle externally. The external cutaneous nerve passes beneath the anterior-superior spine, but above the anterior-inferior spine of the ilium.

The highest part of the crest of the ilium, as I have found by measuring a large number of bones, lies nearly in a vertical line, bisecting a line drawn from the anterior-superior to the posterior-superior spines. The spermatic cord lies upon Poupart's ligament, just external to the spine of the pubes. Abduct the thigh, and you will find the rounded tendon of the adductor longus leading up to the pubic spine. The spine of the pubes is outside the neck of an inguinal hernia, but inside the neck of a femoral rupture. Define the last lumbar spine and the spines of the sacrum. There is sometimes a deficiency of ossification of the laminæ of the last lumbar vertebra; this may lead to spina bifida, or slipping forwards of the vertebra (spondylolisthesis). The spinal cord descends to the lower border of the first lumbar vertebra in the adult. In the fœtus it occupies the whole length of the canal. At birth it reaches to the third lumbar vertebra.

The cerebro-spinal fluid descends to the level of the third sacral spine. In bed-sore, opening the sacral canal, fatal meningitis may ensue. The false pelvis lies above the ileo-pectineal line, the true pelvis beneath it. The inlet of the pelvis corresponds to a circle passing through the promontory of the sacrum behind, the ileo-pectineal lines on either side, and the upper border of the symphysis pubis in front. The outlet of the pelvis is bounded behind by the coccyx, in front by the lower border of the symphysis, on either side by the tuberosities of the ischia and sacro-sciatic ligaments. The diameters of the pelvis are of primary importance in obstetrics.

Fractured Pelvis.—This accident is usually the result of severe crushing violence. The common fracture is of the rami of the pubes or ischia, or near one sacro-iliac synchondrosis. The locality and nature of the violence has much to do with determining the seat of fracture. Thus, it may run obliquely across the ilium. The upper lip of the acetabulum may be broken off, complicating a dorsal dislocation of the hip. Before the age of sixteen, the ilium ischium and pubes may be separated at the acetabulum, or the anterior-superior spine may be separated. This is a separate epiphysis, and joins the ilium about the twenty-third year. The main dangers of fractured pelvis are injuries to large vessels, leading to hæmorrhage or aneurism, rupture of the bladder or rectum, and laceration of the urethra. The condition of the bladder and urethra should always be first investigated in a case of fractured pelvis.

Joints.—The sacro-iliac joints are exceedingly strong, and seldom dislocated. Fractures in their vicinity are often confounded with dislocation. When disease attacks these joints, the early symptoms are often obscure, and are generally mistaken for rheumatism or neuralgia. Pains in the course of the obturator nerve, about the penis and perineum, down the sciatic or crural nerves, are all not uncommon. This joint has no true synovial membrane, except in children and

females. There are two plates of cartilage on either bony surface, separated by soft pulpy connective tissue, the interstices of which contain glairy fluid.

The joint of the symphysis pubis is constructed on the following plan. There is an interposed plate of fibro-cartilage adherent to the bones on either side, and the centre of this is softened, forming a cavity which contains a glairy fluid. This is said to be more largely developed in females. The movement of these joints is exceedingly limited, and is chiefly exercised in parturition. The sub-pubic ligament is a firm structure which completes the pubic arch. The membranous urethra lies about an inch beneath it, and, when violence is applied to the perineum, this portion of the tube being violently jammed against the ligament often gives way. The dorsal vein of the penis is also found immediately below the sub-pubic ligament.

Fasciæ.—The pelvic fascia is of importance in a surgical point of view, for abscesses are guided by it into various situations, at a distance from the original point of disease. Look upon this structure as a firm, dense fascia attached above to the brim of the true pelvis, in front to the back of the pubes, behind to the front of the sacrum and coccyx. The sacral nerves and pyriformis muscle are behind this fascia, the internal iliac vessels and their branches perforate it. The obturator sheet of the pelvic fascia covers the whole obturator internus muscle. Above, therefore, it is attached to the pectineal line, in front to the back of the pubes, behind to the margin of the sacro-sciatic notch and the sacro-sciatic ligaments, below to the margin of the rami of the pubes and ischium. Here it joins with the falciform process of the greater sacro-sciatic ligament, and encloses the pudic vessels and nerve. This fascia, at the upper part of the thyroid foramen, is interrupted and forms the lower boundary of a small notch, through which the obturator vessels and nerve leave the pelvis. In hip disease, implicating the floor of the acetabulum, this fascia becomes greatly thickened, shutting off the pelvic cavity

from abscess, or the manipulations of operators. The inner surface of this fascia looks towards the pelvis, and is lined in its upper third by peritoneum. Its lower two-thirds looks towards the ischio-rectal space. The recto-vesical sheet of the pelvic fascia springs from the obturator fascia, in a line extending from the back of the pubis to the ischial spine. In front it is attached to the back of the pubis, behind it blends with the fascia covering the sacrum and pyriformis muscle. The levator ani muscle arises between the recto-vesical and obturator fasciæ.

The recto-vesical fascia, thus attached on either side, descends in a broad sheet, and blends with its fellow of the opposite side, closing the outlet of the pelvis. It is perforated by the rectum and vagina in the female, the rectum and urethra in the male. This fascia forms the pubo-prostatic ligaments of the bladder, and the lateral true ligaments of that organ. A fold passes between the bladder and rectum. Further, it encloses the prostatic and seminal vesicles, and here is continuous with the deep layer of the triangular ligament of the perinæum.

One of the principal dangers in lateral lithotomy for a large calculus is the tearing of this fascia, and subsequent diffuse inflammation. A quantity of cellular tissue lies about these fascial planes; and, when you study obstetrics, you will find that, from uterine causes, inflammation of the pelvic fascia is very common — a hard "board-like" swelling, on vaginal examination, being readily detected.

Muscles.—The muscles which assist in closing the floor of the pelvis are the levator ani, sphincter ani, and the coccygeus. The psoas muscle may be roughly delineated by forming an acute-angled triangle, the base of which corresponds to a line drawn along the front of the spine, from a point two inches below the umbilicus to full six inches above it, and the apex to a point in the thigh just below the saphenous opening. The iliacus would be roughly delineated by a fan-shaped figure, the base of which corresponds to the margins of the iliac fossa, the apex to the insertion of the psoas.

The surgical relations of the psoas magnus are as follows: —It is covered by the iliac fascia, ligamentum arcuatum, internum, peritoneum, and is crossed by Poupart's ligament. The psoas is also in relation anteriorly with the kidneys and renal vessels, the spermatic vessels, the ureter, and genito-crural nerve. The ascending and descending colon lie in front of the muscle on either side. Outside it are the external iliac vessels, behind it the vertebræ and the quadratus lumborum muscle. By its inner border this important muscle is in relation with the bodies of the vertebræ, the sympathetic, the vena cava on the right, the aorta on the left side. The portion of the muscle which is in the thigh is covered by the fascia lata. Behind it overlies the capsule of the hip, a bursa being interposed. The iliacus and anterior-crural nerve lie outside it, the pectineus and femoral artery to its inner side.

Lymphatics.—The lymphatic system of the pelvis is complicated. For surgical purposes the following points are of importance :—

A cluster of glands surrounds the external iliac artery. These become enlarged and hard secondarily to the superficial inguinal glands in malignant disease of the scrotum, penis, and lower extremity. This serious complication of such affections is too readily overlooked. Numerous glands are placed round the internal iliac artery on the front of the sacrum. They receive the lymphatics from the bladder and rectum, and may be affected in malignant affections of those parts.

The lumbar glands surround the commencement of the aorta and cava. They receive the lymph from the iliac glands, from the kidneys and supra-renals, and from the testes and ovaries. It is often difficult to determine whether or no these glands are affected in malignant diseases of various parts, remembering that they lie close to vessels and nerves. Neuralgia is often a suspicious sign; so is œdema of one extremity, and a sense of pain and resistance on deep palpation.

The Bladder.—The surgical importance of the relations and position of the bladder is very great. When empty it is a

pelvic viscus; when distended it may occupy the greater part of the abdomen, and has been even tapped in error for ascites, or mistaken for an ovarian cyst in females. In children the bladder is much higher in the pelvis than in adults, and this is one of the difficulties of lateral lithotomy in boys. In "rickety" and deformed pelvis, also, the bladder may be almost entirely an abdominal viscus. The part of the bladder uncovered by peritoneum, when the viscus is moderately distended, is the front part or pubic surface. This is in relation with the parietal layer of the pelvic fascia, the back of the pubes, and the abdominal wall for about one inch and a half. The bladder can be tapped above the pubes, or opened in the high operation for stone, without wounding the peritoneum. Posteriorly the peritoneum is reflected from the bladder to the rectum, forming the recto-vesical pouch, and a small surface of the bladder just behind the prostate is uncovered by this membrane. This part of the bladder corresponds to the trigone. The vesiculæ seminales are to be detected on either side, and it is in this spot that the bladder is tapped per rectum. The summit of the bladder is connected with the umbilicus by the urachus and a fold (suspensory fold) of peritoneum. The obliterated hypogastric arteries pass from the sides of the bladder to the umbilicus. These structures are often seen in abdominal section. The urachus is the remains of the allantois, and is usually a solid cord, but sometimes it has been found patent, and urine has issued from the umbilicus. The lateral true ligaments of the bladder are connective tissue, the false, peritoneal folds. The anterior ligaments (pubo-prostatic) fix the neck of the viscus to the floor of the pelvis. The vesical arteries are from the internal iliac. The veins are large and tortuous; they form plexuses about the front and neck of the bladder, and in old men are serious sources of hæmorrhage in operations involving these parts. In the supra-pubic operation these veins appear as a dense plexus in the fat above the bladder; they should be divided between ligatures, or gently drawn aside. The lymphatics of

the bladder enter the sacral and iliac glands. These are enlarged in cancerous disease of the organ. A full bladder readily ruptures from external violence. The rent is usually found posteriorly, and is intra-peritoneal. Extra-peritoneal rupture must be near the neck of the bladder, and is usually the result of laceration by broken bone.

The Prostate.—The position and relations of the prostate are of great surgical interest. In shape and size it resembles a large chestnut, and weighs about six drachms. The prostate is placed obliquely. The apex looks forwards and downwards, and is in contact with the posterior layer of the triangular ligament. The base forms the front boundary of the trigonum vesicæ. The under surface rests upon the rectum. The upper surface is in relation with the back of the pubes and pubo-prostatic ligaments. The urethra perforates the gland near its upper surface. About one inch and a quarter of urethra lies within the prostate. This is the widest part of the urethra. On its floor is an elevation of muscular fibres, fibrous tissue, and mucous membrane—the verumontanum. A recess within this contains the slit-like openings of the ejaculatory ducts. The orifices of the prostatic ducts are on either side. The prostate is usually described as consisting of these lobes. If you dissect the gland you will have a difficulty in recognising this. The middle portion of the prostate in cases of hypertrophy often bulges upwards, causing obstruction, and giving the appearance of a lobe. The prostate is surrounded by a dense fibrous capsule derived from the recto-vesical fascia. Between the layers of this is a plexus of veins of large size. They receive the dorsal vein of the penis, and communicate freely with the iliac veins. The prostatic arteries are derived from branches of the internal iliac. To mark a perineal incision that would reach the prostate, keep strictly in the middle line, about one inch in front of the anus.

Sigmoid Flexure and Rectum.—The sigmoid flexure is not so curved as its name would imply. This portion of the large intestine has obtained peculiar interest of late on account of

its being opened in "inguinal" colotomy. The incision is curved, about two and a half inches long, and placed two fingers'-breadths above the anterior-superior spine. All the structures of the abdominal wall are divided. The rectum is about eight and a half inches in length, and extends from the left sacro-iliac joint to the anus. It is smooth, not sacculated, having no longitudinal bands. The relations of the rectum are as follows:—In front is the peritoneum, small intestine, base of the bladder, prostate, membranous urethra and perineum. Behind is the peritoneum, concavity of the sacrum, the sacral glands and nerves, and the superior hæmorrhoidal artery, the termination of the inferior mesenteric. On either side of the gut is the levator ani muscle and the ischio-rectal fossa. A quantity of areolar and fatty tissue binds the gut to its neighbouring parts. This is of surgical importance, it explains the burrowing of abscesses in this situation. The peritoneum covers the anterior surface of the rectum to within about three inches from the anus, when it is reflected on to the bladder or uterus, forming the pouch of Douglas; posteriorly, the peritoneum covers the rectum for about four inches, as far as the concavity of the sacrum, forming the meso-rectum. Practical surgeons know that the extent to which the bowel is covered by peritoneum is variable. The external sphincter extends up the bowel for about half-an-inch. There an indistinct whitish ring marks the boundary between it and the internal sphincter. The latter is formed by a belt-like thickening of the circular muscular fibres of the bowel. It is about one inch from the anus, and half-an-inch in width. The arteries of the rectum are derived from the termination of the inferior mesenteric, with hæmorrhoidal branches of the pudic and internal iliac. In the last four inches of the gut they run in the muscular coats of the bowel mainly in parallel lines. The larger ones come from the superior hæmorrhoidal. This vessel divides into its large terminal branches about three inches from the anus. The large vessels enter internal piles from above. In "snipping" the mucous membrane at the

base of a pile before applying a ligature, cut on its lower or anal aspect.[1] The rectal veins are numerous, plexiform, and tortuous; they pierce the coats of the bowel obliquely, and are therefore compressed by hard fæces or powerful straining. The hæmorrhoidal veins of the systemic and portal circulation communicate freely here, and hence congestions of the portal vein are apt to manifest their consequences in this situation by rectal bleeding and hæmorrhoids.

On introducing your finger into the rectum, you will feel the grasp of the sphincters—the folds of mucous membrane (Houston) that are so apt to entangle a bougie. Anteriorly you detect the prostate and base of the bladder with the vesiculæ seminales (if enlarged); posteriorly, the sacrum and coccyx. In the female you will feel the recto-vaginal partition and the cervix uteri. The latter I have often known mistaken for a tumour pressing on the bowel, by those not accustomed to examine these parts. The rectum is plentifully supplied with nerves. Yet its mucous coat is not very sensitive. Hence, in commencing cancer of the rectum, patients will often not believe the diagnosis, because they have suffered no pain. Round the anus, however, hæmorrhoidal twigs of the internal pudic nerve and the fourth sacral nerves are distributed. The distribution and connections of these will explain the curious neuralgic symptoms that are associated with ulcers of the rectum, and also the close association between symptoms of rectal and bladder disease—a point of primary practical importance.

Excision of Rectum. — In this operation, performed for malignant growths low down in the bowel, it is needful, if possible, to avoid the peritoneum. The operator may proceed higher on the posterior than the anterior wall. The bleeding from the larger vessels just mentioned is excessive, and they must rapidly be clamped as divided. Great caution is needful in separating the gut anteriorly, from the urethra in the male, the vagina in the female.

[1] I do not enter into the question, whether internal piles contain arteries. I have seen arterial bleeding from them, which is an important clinical point.

In removing a diseased ovary, the pedicle of the tumour will contain the ovarian artery and veins, the ligament of the ovary, often the Fallopian tube spread over the tumour, lymphatics, sympathetic nerves, cellular tissue, and peritoneum.

If the entire uterus were removed for fibroid tumour, or carcinoma, it is very needful to carefully secure the broad ligaments on either side. These contain the Fallopian tube, round ligament of the uterus, and the ligament of the ovary, the uterine vessels and nerves, and some lymphatics. In cases of large tumours, the uterine arteries may be of great size. These structures are contained between the serous folds of the peritoneum and some cellular tissue. The recto-uterine and vesico-uterine folds of peritoneum need division, and, finally, the cervix uteri, or upper part of vagina.

CHAPTER VI.

EXTERNAL GENITALS.

Scrotum.—If you were to cut through the scrotum down to the testis, you would divide the skin and "dartos," the inter-columnar (external spermatic) fascia, the cremasterie muscle and fascia, the infundibuliform fascia (fascia propria), with the parietal layers of the tunica vaginalis. These structures are divided in the operation of castration. The dartos tissue is subcutaneous and continuous with the superficial fascia of the abdomen and perineum. It is loose, brownish-coloured areolar tissue, containing much unstriped muscle, and endowed with contractility. This tissue will readily become œdematous in inflammatory or dropsical affections. As an aid to memory, you will notice that each tunic of the testis is derived from one of the coverings of the abdominal wall: thus, the external oblique gives the external spermatic fascia, the internal oblique, the cremasteric tissue, the transversalis fascia, the infundibuliform fascia, and the peritoneum, the tunica vaginalis. Note also that an incomplete septum extends from the dartos backwards to the root of the penis, so that the scrotum is divided into two incomplete sacs, one for each testis.

The cremaster muscle and fascia being derived from the internal oblique, have nearly the same attachments as the lowest fibres of that muscle, namely, from the inner part of Poupart's ligament externally, and the spine and crest of the pubes internally, the striped muscle fibres passing in long loops

between Poupart's ligament and the pubes. The cremaster is supplied by the genital twig of the genito-crural nerve, which traverses the inguinal canal. Retraction of the testis is effected by the cremaster. The genito-crural nerve comes from the first and second lumbar nerves, which have free communications with the sympathetic system. Hence retraction of the testis and pain down the thigh are often found in renal calculus and malignant disease of the kidney.

The tunica vaginalis is derived from the peritoneum, and as the testis descends from behind that membrane, a double layer of it descends in front of the gland, enveloping it almost completely, but being reflected from the epididymis behind, where the vessels and nerves enter. To the epididymis the tunica is connected by loose areolar tissue. Thus inflammation rapidly spreads from the epididymis to the tunica vaginalis and scrotum, and in acute epididymis a slight amount of hydrocele and œdum of the scrotum are usually observed. Conversely, if you inflame the tunica vaginalis, epididymitis usually occurs, a great objection to the injection treatment of hydrocele. I wish you to distinctly understand that the testis is behind the tunica vaginalis, not in it; when you see the testis so depicted,-the illustrations are inaccurate. The tunica vaginalis extends a variable distance upwards over the front of the cord, but is usually obliterated above. The parietal layer extends upwards much farther than the visceral layer. In some cases there is a more or less free communication between the sac and the abdominal cavity, and this leads to congenital hydrocele, or hernia, should a coil of gut descend through the opening. When the tunica vaginalis is distended it is of a pyriform shape, cut off distinctly from the abdominal cavity above, and with a slight constriction about its centre. A swelling with these characteristics is almost certainly a hydrocele. The testis lies posteriorly in a hydrocele, and is with difficulty to be felt. In an ordinary hernia it is also below and behind, but can usually be readily made out. When you read of these subjects in the appropriate treatises, you will find

that, under certain eireumstanees, the testis may be in front of a hydroeele.

The vessels of the scrotum are, the external pudic from the femoral artery, the superficial perineal from the internal pudie, the eremasteric from the deep epigastric. The nerves are, the ilio-inguinal from the first lumbar nerve, becoming cutaneous at the exterual abdominal ring; the superfieial perineal nerves, the inferior pudendal, and the genital branch of the genito-crural nerves. There is an abundant distribution also of sympathetic filaments. Violent "referred" neuralgic pains of the scrotum, penis, and testis, are found in a variety of affections, at a distance from these parts. Examples are, stone in the bladder, acute perityphlitis, necrosis of the lower vertebræ, malignant growths about the pelvis, and calculus or malignant affections of the kidney.

The Penis.—The two eorpora cavernosa plaeed side by side, separated by a septum—composed of interlacing fibrous tissue, and surrounded by a very densc and elastie tunic—form thc main bulk of the body of the penis. Their rounded ends arc received into the glans, which is the turned-up and expanded end of the corpus spongiosum. The corpus spongiosum eommences posteriorly by a dilated portion of the bulb, which rests upon the triangular ligament and receives an investment from the accelerator urinæ muscle. A little above and anterior to the bulb the urethra enters the corpus spongiosum, the bulb thus projecting backwards over the membranous urethra to a small extent.

The sheath of the penis is formed of loosc skin, arcolar tissue, and fascia, which is continuous with thc superfieial fascia of the abdomen and scrotum. At the neek of thc glans, the intcgument, foldcd on itself, forms the prepuce. Over thc glans the integument changes its charaeter and bceomes thin, moist, and very adhcrent to the deeper parts. Numcrous glands (glands of Tyson) are found in this situation. The suspensory ligament of the penis is a thickened band of superfieial fascia, which extends from the front of the symphysis to

the dorsum of the organ. The penis is firmly fixed to the pubes also, by two crura. In amputation, it is essential to restrain hæmorrhage by tying an elastic band round the root of the organ. The corpus spongiosum must be kept a little longer than the corpora cavernosa, and the cut edges of the urethra united to the skin.

The knife would divide the skin and fascia, the dorsal arteries, vein, and nerves, the arteries of the corpora cavernosa, the arteries of the septum, the corpora cavernosa themselves, and the corpus spongiosum. All the above arteries would require ligature. The superficial lymphatics of the penis, as has been already stated, enter the superficial inguinal glands; the deep lymphatics pass to the pelvic glands.

The Testes.—Each testis weighs on an average about six drachms, and is of an oval form; this shape is maintained by most tumours of the testis itself. The epididymis is a long, narrow body overlapping the testis posteriorly, and projecting above it. The enlarged upper part is termed the globus major, the lower part the globus minor, the intermediate part the body. This structure is composed of the windings and flexures of the canal of the epididymis, which is said to be upwards of twenty feet long. Above and to the outer side of the globus major of the epididymis are fœtal structures, the so-called "Hydatid of Morgagni" and organ of Giraldès. These are the remains of the Müllerian duct and Wolffian body respectively. A cystic dilatation of the remains of the Wolffian body has been held to be one pathological cause of encysted hydrocele.

If you traced a spermatozoon from its origin in the testis to the urethra, you would find the journey long and complicated. At first found in the tubuli seminiferi, it is conveyed to the tubuli recti, and thence to the tubes of the rete testis. From these, in the centre of the gland, it would travel by way of the vasa efferentia through the coni vasculosi to the excretory duct in the head of the epididymis. After emerging from the epididymis, the cell would travel nearly two feet along the vas

deferens, and ultimately might reach the seminal vesicles, or be expelled through the ejaculatory ducts, in front of the verumontanum, into the prostatic urethra. The testis is held to the bottom of the scrotum by a fibro-cellular band, the remains of the gubernaculum, and a fibro-serous fold, the mesorchium, can often be detected posteriorly.

The structures composing the cord, when its coverings are removed, are the vas deferens, the artery of the vas from the superior vesical, the spermatic artery from the aorta, the spermatic convoluted veins, the deep lymphatics of the testis, sympathetic nerves, and the remains of the obliterated funicular process. By referring to the coverings of the testis, and the structures forming the cord and holding the testis in position, you will note what it is needful to divide, and what vessels require ligature in the operation of castration. The spermatic veins have imperfect valves, and are much convoluted. The left vein passes to the renal vein, the right to the vena cava direct. The left vein passes behind the sigmoid flexure, and is said to be pressed upon when the large intestine is loaded with fæcal contents. The indirect course of the blood entering the renal vein at a right angle, and the relation of the vein to the intestine, are said to be sufficient cause for the frequent occurrence of varicocele on the left side.

External Genitals of the Female.—By the term "vulva" is usually understood all the external organs of generation—as, the mons veneris, labia, hymen, carunculæ, clitoris, and orifice of the urethra. The nymphæ pass downwards and backwards from the sides of the clitoris, and the interval between them is termed the vestibule. If you examine the vestibule from above downwards, you will find the clitoris above, the orifice of the urethra about an inch lower down, and next the circular opening of the vagina. All these structures should be verified on the cadaver, and you should especially practise the passing of the female catheter. This is best done by passing the forefinger of the left hand a little way into the vagina,

and sliding the catheter along the pulp of the finger, just above the vaginal orifice. The instrument will almost certainly pass into the urethra, and the end of the finger will feel it passing along that canal on the anterior vaginal wall. Other points of surgical interest about the external female genitals are as follows :—The inguinal canal of the female is smaller than in the male. It contains the round ligament of the uterus and a pouch of peritoneum, which, when not obliterated, is termed the canal of Nuck. Herniæ are occasionally found in the inguinal canal and labia majora of the female, and hydrocele of the canal of Nuck is also met with. The labia majora are very vascular, and contain erectile tissue. Large extravasations of blood and hæmatomata are not uncommon in them after any sort of violence. There are numerous mucous glands about the vaginal orifice, but the more important of these are the glands of Bartholin, two large racemose glands situate on either side of the vaginal orifice, beneath the superficial perineal fascia, and in front of the transverse perineal muscles. The hymen is an incomplete fold of mucous membrane situate at the vaginal orifice. Its shrivelled remains constitute the "carunculæ myrtiformes." This structure is most diverse in shape and completeness, and any one founding an opinion on the chastity of a female from the appearances of this membrane is apt to be grievously misled.

The ducts of the glands of Bartholin, when blocked, form cysts of considerable size, which are not uncommon. Occasionally they become inflamed, and may give rise to troublesome abscesses.

Urethra.—The female urethra is one inch and a half long, and is very dilatable. It is imbedded in the anterior wall of the vagina, and surrounded, between the layers of the triangular ligament, by the compressor urethræ muscle, as in the male.

On making a vaginal examination, you ascertain the presence or absence of the hymen ; the rectum can be felt behind often

distended by scybalous masses; the urethra lies in front, and a catheter in it is readily distinguished. The os and cervix uteri are reached above, and you can examine the condition of these structures. Behind, you examine the pouch between the uterus and rectum, a common situation for swellings, fluid and solid; round the sides and anteriorly you search also for inflammatory effusions. By pressing above the pubes the size and weight of the uterus can be estimated, or the connections between it and abdominal and pelvic tumours made out. Some authorities declare that they can detect more than this, and can feel and estimate the condition of the ovaries; but the above are most of the conditions that an ordinary observer may expect to be able to certainly and undoubtedly feel and estimate.

The female perineum contains the following muscles:—The external sphincter, the transversus perinei, the erector clitoridis and the sphincter vaginæ, the constrictor urethræ, and the levator ani, which encloses the vagina on either side. The pudic artery in the female is smaller than in the male. The superficial perineal twigs pass to the labia, the artery of the bulb to the cavernous tissue of the labia (bulb of the vestibule), the artery of the corpus cavernosum and artery of the dorsum of the clitoris, are its small terminal twigs.

The relations of the vagina are as follows:—Anteriorly is the urethra and neck of the bladder. Posteriorly lies the rectum. It is especially important to remark that the upper and posterior fourth of the vagina is in relation with the peritoneum. Fatal ruptures of the vagina have occurred here—in parturition, from attempts at criminal abortion, and in rape. Fistulous openings between the vagina and bladder in front and rectum behind are not uncommon from sloughing after prolonged labour, the clumsy use of forceps, or cancerous ulceration. They are miserable infirmities, and the openings are often most difficult to close. The vagina is very vascular, receiving vaginal branches from the internal iliac, and also

twigs from the pudie, vesieal, and uterine arteries. Wounds of the eanal may be fatal from hæmorrhage. These may oeeur through the sudden breakage of a chamber utensil—a portion of the broken ware seriously wounding the part. Again, wounds of the vagina are found in eriminal attempts to proeure abortion, with sharp instruments used by unskilled hands.

CHAPTER VII.

UPPER EXTREMITY, WRIST AND HAND, LYMPHATICS OF THE UPPER EXTREMITY, EFFECTS OF LOSS OF FUNCTION OF THE LARGE NERVES.

Bony Prominences.—Place your finger in succession on the head of the ulna and the styloid process of the ulna; these should not be confounded. Feel the styloid process of the radius, and note that the styloid process of the radius descends lower than the styloid process of the ulna; abduction of the hand is therefore less free than adduction.

The lower epiphyses of the ulna and radius comprise the styloid processes in both the bones. The lower epiphyses join the shaft about the twentieth year, the upper ones about the sixteenth year. Separation of the lower epiphysis of the radius closely simulates dislocation of the wrist, and is often mistaken for it. The distinction is obvious; in separation of the epiphysis the styloid process moves, and is displaced with the lower fragment. Colles' fracture is a common injury about the wrist of elderly people after heavy falls on the hand. It is often more or less impacted, the upper fragment being driven into the lower; it then may be most difficult to get the fracture into proper position.

The line of fracture runs about three-quarters of an inch above the base of the styloid process. The lower fragment carrying the carpus projects dorsally, being driven upwards, backwards, and towards the ulna. The lower end of the upper fragment forms a projection in front of the wrist. The hand is abducted, and the styloid process of the ulna projects

markedly. The inferior radio-ulnar ligaments are not usually broken. The indications for treatment are to extend and adduct the hand, and to maintain daily passive movements of the fingers. The amount of stiffness that persists about the wrist and fingers of an old rheumatic person after the union of this fracture is remarkable, and needs the greatest patience and perseverance on the part of the surgeon, who, in the end, may not meet with great credit.

Place the hand supine, and note the prominence of the pisiform bone on the inner side; and the prominence on the outer side of the trapezium and tubercle of the scaphoid. Feel for the sesamoid bones on either side of the metacarpo-phalangeal joint of the thumb. Define the outline of the metacarpal bones and phalanges, and especially note the shape and exact position of the bases of the latter bones. The heads of the metacarpal bones and phalanges are convex, the bases concave.[1] The second metacarpal bone is the longest and most fixed at its base, hence it may be broken in pugilistic encounters. The metacarpal bones are each developed from two centres of ossification—one for the shaft and one for the head in the four inner bones, one for the shaft and one for the base in the metacarpal bone of the thumb. The phalanges are developed like the metacarpal bone of the thumb. The epiphyses of these bones join the shaft at about the twentieth year, on a general average. They may be separated from the shafts by violence, or be the seat of chronic inflammation in congenital syphilis and tuberculosis.

Muscles, Tendons, and Fasciæ.—Now flex the hand and define the tendons as they start into relief. On the ulnar side of the radial artery lies the flexor carpi radialis; if this is traced into the hand, it is found inserted into the base of the metacarpal bone of the index finger. The palmaris longus is visible, passing to the palmar fascia and annular ligament,

[1] In the inter-phalangeal joints, the proximal ends of the phalanges have a central elevation and two lateral depressions; the central elevation fits into the depression between the condyles of the head of the phalanx.

beneath it lies the median nerve. Proceeding internally you feel the flexor carpi ulnaris passing down to the pisiform and fifth metacarpal bones. The ulnar artery lies just to its radial side.

The outline of the pronatur quadratus muscle is quadrilateral, the muscle occupying about the lower fourth of the ulna and radius. Its lower margin corresponds to a line drawn across the wrist just above the bases of the styloid processes. The muscle is covered by the flexor tendons, the median and ulnar nerves, and the ulnar and radial vessels. It overlies the radius and ulnar and the interosseous membrane. Just above its upper border the anterior interosseous artery passes to the back of the forearm, and a branch descends from it through the muscle to the carpal arch, which lies near the lower border of the pronator quadratus. Extend the thumb forcibly. The first tendons which start into relief, investigating from before backwards, are the extensors of the metacarpal bone and first phalanx of the thumb. These are so close together as to appear but one. Next you come upon the extensor secundi internodis pollicis, and the tendons of the extensor communis digitorum muscle, with the extensor indicis, and extensor minimi digiti placed to the ulnar side of their corresponding common extensor tendons. The tendon of the fourth finger is connected by fibrous bands to the tendons of the middle and little finger; these are sometimes divided in violinists to give freer range of motion to the fingers.

The tendons of the extensor carpi ulnaris, extensor carpi radialis longior and brevior, are not seen. The latter two tendons are found with the radial artery in the hollow above the base of the metacarpal bone of the thumb. The eminence of the "ball" of the thumb is formed by the abductor pollicis overlying the opponens and flexor brevis pollicis. The adductor pollicis fills the interval anteriorly between the thumb and index finger. You may mark it out by drawing a triangle, the base of which corresponds to nearly the whole

length of the middle metacarpal bone, the apex to the internal sesamoid bone of the thumb.

The muscular eminence on the ulnar side of the hand is formed by the abductor minimi digiti and the flexor brevis minimi digiti. Pronating the hand, the abductor indicis, or first dorsal interosseous muscle, is seen bulging in the first interosseous space, between the thumb and the index finger. This muscle wastes very early in paralysis of the ulnar nerve. The other three dorsal interosseous muscles fill the intervals between the four inner metacarpal bones posteriorly. The four dorsal interossei muscles abduct the fingers from the middle line, the three palmar interossei adduct them towards it. The interossei are also said to aid in flexion of the first and extension of the last two phalanges. Consequently, when they are paralysed, the first phalanges have a tendency to become extended, and the last two flexed. The anterior annular ligament blends with the fascia of the forearm above, and the palmar fascia below. It is attached externally to the scaphoid and trapezium, internally to the pisiform and hook of the uneiform bones. The ulnar nerve and artery, the superficialis volæ artery, and cutaneous twigs of the median and ulnar nerves, pass over it. The flexor carpi radialis tendon occupies a separate compartment in the annular ligament. Beneath it are the flexor tendons, with their synovial sheaths, and the median nerve. The posterior annular ligament has six separate compartments beneath it for extensor tendons and synovial membranes.

The palmar fascia is an important structure from a surgical point of view, and you should know its extent and attachments. The central portion of this fascia is thick and dense, the lateral portions are comparatively thin. The fascia takes origin from the annular ligament and palmaris longus tendon, and, gradually broadening like a fan, divides into four processes, which pass to the fingers and join the digital sheaths. Transverse fibres pass between these processes, binding down the lumbricales and the digital vessels and nerves. Other

transverse fibres blend with the transverse metacarpal ligament which connects the heads of the metacarpal bones laterally. This structure must not be confounded with the superficial transverse ligament which is found under the skin at the "webs" of the fingers. Processes pass deeply backwards from the palmar fascia to the metacarpal bones, separating the interosseous muscles, and being continuous with a thinner layer which covers these structures. Thin septa also separate the flexor tendons from the muscles of the thumb and little finger respectively. The processes of this fascia thus form more or less complete channels for the passage of the flexor tendons.

Some of the principal surgical points relating to the palmar fascia are as follows:—Its great density renders suppuration beneath it a serious matter—the pus burrowing extensively, and the subsequent reparative processes causing serious puckering and deformity of the tissues of the hand generally. In cases of palmar abscess, an opening should be made early under anæsthesia; passing the finger into the cavity, the fascia should be freely divided, so that all recesses are quite laid open. The position of the superficial arterial arch and digital vessels should be remembered.[1] After this the hand should be placed upon a splint with the fingers extended, and the cavity dressed "from the bottom." Passive movement of the fingers should be early carried out. "Dupuytren's contraction" is a well-known and troublesome contraction of the palmar fascia, especially those lateral slips of it which pass to the tendon sheaths of the little and ring fingers. The tendons are never contracted in this affection, though the thickened slips of fascia closely simulate tendons. The contracted bands may be subcutaneously divided, or even dissected out entirely. Wounds of the deep palmar arch are among the most serious and dangerous cases of arterial hæmorrhage. The density of the palmar fascia and its various processes partly accounts for this, as it is well-nigh impossible to cut down and secure the

[1] See page 112.

bleeding point. Sarcomatous tumours may grow from this fascia; compound ganglion may be found in connection with the synovial sheaths of the tendons beneath it; lipomata are also sometimes found beneath the palmar fascia.

Sheaths of the Tendons.—You should clearly understand that the tendons are surrounded by both fibrous and synovial sheaths. In certain positions in the palm and opposite the joints of the fingers, the fibrous sheath is more or less incomplete. Pus may therefore burrow out from the sheaths of the tendons, or suppurative processes may extend to the synovial sheaths themselves from without. The fibrous sheaths are most dense and firm opposite the middle of the phalanges. The deep flexor and common extensor tendons are inserted into the last phalanx. No synovial sheath overlies the last phalanx, the pulp of the finger being continuous with the fibrous aponeurosis covering the bone. There are two synovial sheaths beneath the annular ligament. That surrounding the flexor longus pollicis tendon extends from about one inch above the annular ligament to the last phalanx of the thumb. The large sheath surrounding the tendons of the deep and superficial flexors extends from about an inch and a half above the annular ligament to the middle of the palm. The sheath to the little finger frequently reaches to the last phalanx. The synovial sheaths of the three middle digits do not communicate with the synovial sheath at the wrist. They extend up the palm only as far as the transverse furrow observed on flexing the fingers on the palm. The practical bearing of these facts on the surgery of whitlow and ganglion is great, and will be again alluded to.

Joints, Synovial Membranes, Bursæ.—Mark out the wrist joint by a line drawn with its convexity upwards on the back of the wrist, from the middle of the lower end of the radius to a corresponding point of the ulna. This joint lies about one inch higher than the tip of the styloid process of the radius. It is formed by the radius and inter-articular cartilage above; the seaphoid, semi-lunar, and cuneiform bones below. The

inferior radio-ulnar joint has a separate synovial membrane, situate above the inter-articular cartilage. Disease of this articulation may exist, or the lower end of the ulna may be removed, without implicating the wrist joint proper. The movements permitted in the wrist are flexion and extension, abduction and adduction. Some eminent authorities are of opinion that extension of the wrist is more free than flexion. The main bond of union between the radius and ulna inferiorly is the inter-articular fibro-cartilage, and in a minor degree the anterior and posterior ligaments. These structures are seldom torn, even in bad fractures. The ligaments of the metacarpo-carpal joints are dorsal-palmar and interosseous; of the metacarpo-phalangeal, anterior and two lateral. A very important structure, the transverse ligament of the metacarpus, binds the heads of the metacarpal bones together. The movements permitted in these joints are flexion and extension, abduction and adduction. Only flexion and extension are permitted in the joints between the phalanges. The joint between the metacarpal bone of the thumb and the trapezium is capable of movement in every direction. There is one synovial membrane between the inter-articular cartilage and the lower end of the ulna. There is another between the radius and inter-articular cartilage above, and scaphoid, semilunar, and cuneiform bones below. The metacarpal bone of the thumb has a separate synovial sac where it articulates with the trapezium; so has the pisiform bone where it articulates with the cuneiform. The fifth synovial membrane is extensive. It lies between the two rows of carpal bones, sends prolongations between them and also to the bases of the four inner metacarpal bones.

Synovial bursæ may be produced over any of the knuckles, or other bony prominences, in those who expose these parts to friction or pressure. Two small bursæ are found beneath the insertions of the extensor carpi radialis longior and extensor carpi radialis brevior tendons into the bases of the second and third metacarpal bones. There may be also bursæ over

the sesamoid bones on either side of the metacarpo-phalangeal joint of the thumb.

Arteries.—The superficial palmar arch is formed by the ulnar artery anastomosing with the superficialis volæ or radialis indicis branch of the radial artery. Draw a curved line, with its convexity downwards, from the radial side of the pisiform bone, across the palm to a point opposite the intersection of two lines drawn on the palm from the cleft between the index and middle fingers vertically, and junction of the thumb with its "web" horizontally. Note especially that the arterial arches of the palm are curved—not straight; it is inaccurate to delineate their course by lines drawn across the palm at different levels, as is commonly taught. The main branches of the superficial arch are those communicating to the end of the deep arch, and the digital vessels. The digital arteries run forwards along the interosseous spaces, and bifurcate at the clefts of the fingers, but the innermost digital artery does not bifurcate. These vessels run along the sides of the fingers beneath the digital nerves. Tiny twigs of them pass through the sheaths of the tendons, and traverse the fibrous slips which pass from the sheath to the tendon. These little vessels are easily compressed and stretched in the inflammatory exudation of acute whitlow, and thus sloughing of the tendon is threatened.

The deep palmar arch is formed by the radial artery anastomosing with the communicating branch of the ulnar. It lies an inch nearer the carpus than the superficial arch, upon the front of the bases of the metacarpal bones. Its course is represented on the palm by a curved line starting from a point on the ball of the thumb opposite the base of the second metacarpal bone, and terminating on the ulnar side opposite the base of the metacarpal of the little finger. Note that the deep arch is covered by the palmar fascia, branches of the median and ulnar nerves, and flexor tendons of the fingers. The principal branches of it are the interosseous and perforating. Both arches communicate freely with the carpal

arches of the radial and ulnar arteries; and, as these communicate with the interosseous arteries above, there is a direct channel by which blood can be brought to the hand after ligature of the radial and ulnar arteries at the wrist. The vessels of the back of the hand run along the interosseous spaces. The first space receives the dorsal arteries of the thumb and index finger; the second, the metacarpal branch of the radial artery; the third and fourth, branches from the posterior carpal arch. These communicate freely with the interosseous palmar twigs.

Nerves.—The ulnar nerve passes over the annular ligament into the hand to the inner side of the ulnar artery. The deep branch supplies in the hand, collectively speaking, the muscles of the little finger, the adductor pollicis and inner head of the flexor brevis pollicis, all the interossei, and the three inner lumbricales. The two superficial branches supply the palmaris brevis, skin of the inner aspect of the palm, the inner side of the little, and adjacent sides of the little and ring fingers. The dorsal cutaneous branch of the ulnar supplies the same digits on the dorsum of the hand, and communicates freely with the radial nerve. The median nerve passes under the annular ligament into the hand beneath the palmaris longus tendon. Collectively speaking, it supplies the following muscles, — abductor pollicis and outer head of the flexor brevis pollicis, the opponens pollicis, and the outermost lumbrical. The digital branches, five in number, supply the sides of the thumb, the index and middle fingers, and half the ring finger. The digital branches of this nerve supply, by a dorsal twig, the skin over the backs of the two last phalanges of the two outer fingers. The radial nerve supplies the same digits posteriorly, but does not extend further than the bases of the second phalanges. In the case of the thumb the radial nerve extends down to the end of the dorsal aspect.

Practical Points.—Dislocations of any of the phalanges are troublesome to reduce, that of the first phalanx of the thumb especially so. The displacement in the latter injury is usually

dislocation backwards of the first phalanx on to the metacarpal bone. The displaced head of the metacarpal bone slips forwards between the tendons of the short flexor and the sesamoid bones. The neck of the metacarpal bone is tightly girt by these structures, and also by the fibrous tissues round the joint. I have never seen much difficulty in reducing this dislocation when recent. Anæsthesia being induced, adduct the thumb into the palm, then pull in the axis of the dislocation, and subsequently extend, so as to sweep the base of the phalanx over the head of the metacarpal bone. When this fails, subcutaneous tenotomy may be resorted to, or the plan of cutting down and with a blunt hook drawing one of the flexor tendons over the head of the metacarpal bone. The joint may be freely opened and resisting structures divided as they are seen. This must be done with strict care and cleanliness, and is then likely to prove successful.

Accidental wounds are very common about the wrist and hand. Wounds about the wrist may divide the tendons, vessels, and nerves. After tying the vessels, you must accurately unite the tendons and nerves by cat-gut sutures. This treatment is too often neglected. Wounds of the palm of the hand, which presumably implicate the deep arch, are treated by pressure and elevation as a rule. If complete elevation of the limb be maintained, undue pressure on the palm is avoided. You should read the various methods of treatment of this accident carefully, as it is difficult to deal with in practice. In crushes and such like injuries of the hand the surgeon should not be too free with the amputating knife; preserve all the tissue possible. If you are in doubt, err on the side of preserving a finger or especially part of the thumb. If possible, preserve two opposing digits, one being the thumb. It is perfectly astounding how useful such an apparently mutilated limb becomes ultimately. In amputating at the metacarpo-phalangeal joint, preserve the head of the metacarpal bone. If you remove this you damage the integrity of the transverse ligament, and thus seriously weaken the

hand. If appearances are to be studied, cut away the bone from above downwards obliquely so that the dorsal prominence only is removed.

Should it become needful to tie the arteries above the hand, for recurrent hæmorrhage from wound of the palm, choose the brachial artery, and not the radial and ulnar. If the radial and ulnar arteries are tied, blood is brought through the interosseous vessels into the carpal arches, and through them to the palmar arches.

It is often useful to clearly understand where to make incisions in the hand and wrist in cases of deep abscess and cellular inflammation. In these cases the incisions should only be made through skin and fascia, a blunt director or the finger of the operator working a way through the deeper parts. The hand may be enormously swollen and puffy. I apply the term "boxing glove" hand to these cases. In the palm, incisions should be placed anterior to the line of the superficial arch. They should be made over the bones, and not over the interosseous spaces. Incisions in the wrist should be placed between the flexor carpi radialis and palmaris longus tendons. A tube may be readily passed from here to the palm in cases of abscess beneath the annular ligament. On the back of the hand, incisions should be made over the bones and not over the interosseous spaces. When an incision is made the effused serum mixed with blood rushes out in the most alarming manner. There is no cause for alarm to those who are forewarned—the bleeding may be allowed to continue, and will prove of the greatest local benefit. You can check it at any moment by elevating the part and applying digital pressure. Incisions in the fingers should be made in the middle line, and should open the sheath of the tendon opposite the middle of the phalanx. They may also be made laterally, especially if there be a tendency to pointing of matter. The sheath of the tendon should not be extensively slit up. Incisions or wounds over the ball of the thumb may wound the "superficialis volæ" branch of the radial artery.

The bleeding from this is profuse, and best controlled by elevation with a compress and "spica" bandage over the ball of the thumb. True "whitlow" is a suppurative synovitis of the synovial sheath of the flexor tendon of the fingers, leading to sloughing of the tendon and subsequent contraction of the affected digit. The common cause is a prick or punctured wound, some septic matter being wiped off and left within the synovial sheath. The worst cases are seen in those who prick their fingers deeply with the spines of fish or poisoned knives, as cooks and butchers. In the country harvesters are very prone to suffer, as they run thorns into the fingers in binding up the corn. You will observe that I venture to differ from many authorities as to the origin of true whitlow. If the suppuration in whitlow extend towards the hand, the burrowing pus usually stops at the transverse furrow observed on bending the palm; for the synovial sheaths do not extend further than this. In the thumb the suppuration may extend up the separate sheath of the flexor longus pollicis to the neighbourhood of the wrist; and the same may occur in the little finger.[1]

The Lymphatics of the Upper Extremity.—In the axilla are several groups of lymphatic glands. There may be glands in the course of the brachial artery, at the bend of the elbow on the ulnar or radial arteries, and just above the internal condyle of the humerus. The latter gland is constant in occurrence. The axillary glands are divided into three groups — the pectoral, the sub-scapular glands receiving lymph from the skin of the back, and the glands around the axillary vessels. A gland may also be found on the costo-coracoid membrane. In cases of chancre of the fingers, or epithelioma of the dorsum of the hand, the practical surgeon examines the regions above indicated for evidences of glandular contamination.

Poisoned wounds and lymphangitis are very common about the hand and forearm. Inflammatory swellings, occurring at the bend of the elbow in the arm or axilla, may arise from

[1] See page 110.

trivial or even unnoticed lesions on the fingers and hands. In cases of lymphadenoma enormous tumours may form in the axilla. These are lobulated, moveable masses, not associated with inflammation or softening, and occurring in anæmic individuals.

Effects of Paralysis of Main Nerves.—The nerves of the upper limb are peculiarly prone to be divided by accidental wounds. They may be pressed upon by the handle of a crutch, implicated in the "callus" of a fracture, interfered with in their functions by the growth of an exostosis from the first rib, or bones of the upper limb. The musculo-spiral nerve is peculiarly often implicated. You will require all your diagnostic powers to determine the cause of paralysis of a main nerve. Recollect that these nerves come from the four lower cervical and first dorsal trunks, and the cause of paralysis may be above the clavicle, in the cervical spinal cord itself, or even due to such a remote cause as lead-poisoning. Thus your search must not be confined to the upper limb alone. Particularly remark that, though a main nerve be divided, the skin supplied by it considerably recovers sensation in course of time. The cause of this very curious phenomenon is probably the communications of the peripheral branches with other nerves.

Suppose now that a boy falls on a glass-covered wall, and sustains a small deep wound above the inner condyle of the humerus. This divides the ulnar nerve, and he is brought to see you nine or twelve months afterwards. There will be a wasted appearance of the forearm on its anterior aspect internally. This is due to paralysis of the flexor carpi ulnaris and inner half of the flexor profundus digitorum muscles. The muscles of the little finger proper will all be wasted, so will the adductor pollicis and inner head of the flexor brevis pollicis; abduction, flexion and extension of the thumb are not lost. On the back of the hand you will be struck with the appearance of the metacarpal bones. They all, more especially that of the ring finger, stand out gaunt and prominent.

This is due to wasting of the interossei muscles. The little and ring fingers have a peculiar claw-like form, the first phalanx being extended and the second and third flexed. This is said to be due to paralysis of the interosseous muscles. When these are in working order, they flex the first phalanx and extend the last two. You can obtain a further proof of the implication of the interosseous muscles, by noting the inability of the patient to abduct the ring and index fingers from the middle one. Now, test sensation by touching with a pencil the dorsal and palmar aspects of the inner side of the hand, the little finger, and the inner side of the ring finger. You will find that sensation is lost or greatly impaired. Lastly, there may be "nutritive" lesions of the skin or joints; but these are of pathological import. These symptoms make one certain that the ulnar nerve is paralysed.

Next, let us suppose that a heavy man has long been using a crutch, on account of a severe fracture of his leg. The musculo-spiral nerve is compressed by the crutch, and its functions damaged. There will be wrist-drop from paralysis of the extensors of the wrist. The supinators are also paralysed; but the powers of supination of the hand are not lost, for the biceps remains in action. The two last phalanges of the fingers can be extended by the action of the interossei muscles. Sensation is impaired over the lower and outer aspect of the arm and dorsal aspect of the upper forearm. The supra-acromial twigs from the cervical plexus supply the skin of the arm on its upper and outer aspect. The skin on the inner side of the arm is supplied by the intercosto-humeral nerve, and though the internal cutaneous branch of the musculo-spiral is affected, sensation is not quite lost.

Sensation is lost also over the radial side of the dorsum of the hand and the dorsum of the thumb, with the index, middle, and outer side of the ring fingers. Sensation over the back of the two last phalanges of the fingers is not lost, since the skin here is supplied by the dorsal twig of the median digital branch. Owing to the free communication with the ulnar

and external cutaneous nerves, the symptoms of radial nerve paralysis usually vary much in completeness. The triceps and anconeous muscles may waste, and the power of extension of the forearm be greatly interfered with.

Should the median nerve be paralysed by a lesion high up, great wasting of the flexor muscles of the forearm and of the pronators ensues. The short muscles of the thumb, the abductor opponens and outer head of the short flexor rapidly waste, and the function of the outer lumbricales is interfered with. Sensation is lost over the palmar aspects of the thumb and two outer fingers, with the radial side of the ring finger, and over the dorsum of the last phalanges of the two outer fingers. A small part of the skin over the ball of the thumb is not anæsthetic, for here the external cutaneous nerve terminates.

The circumflex nerve is sometimes injured in dislocations of the shoulder as it winds round the surgical neck of the humerus. The deltoid muscle wastes rapidly, the arm cannot be raised from the side, and dislocation is closely simulated. The great tuberosity of the humerus is still the most prominent external point about the shoulder, showing that the dislocation is simulated, not real. Were the nerve completely divided, the skin would be anæsthetic over the lower two-thirds of the deltoid.

For a complete and graphic account of these and similar injuries, see *Bowlby on Diseases and Injuries of Nerves.*

CHAPTER VIII.

UPPER EXTREMITY, THE ELBOW AND FOREARM.

Bony Prominences.—Define carefully the external and internal condyles, the olecranon, and the head of the radius. The latter is to be felt during pronation and supination rolling beneath the finger below the external condyle. Trace the shafts of the radius and ulna down to the lower extremities. You will see that the tip of the olecranon lies, when the arm is straight, in a line drawn across the lower end of the humerus through the condyles. The shaft of the ulna is far more easily felt than that of the radius, the posterior surface being subcutaneous. The bones of the forearm are nearest together in extreme pronation, farthest apart in complete supination. A position midway between pronation and supination is usually chosen in adjusting fractures of the forearm. The lower epiphysis of the humerus practically consists of two portions—the external condyle with the articular surface, and the internal condyle: these join the shaft about the seventeenth to the eighteenth year. Remember that the upper epiphysis of the humerus does not unite with the shaft until the twentieth year. The upper epiphysis of the ulna is merely the tip of the olecranon, the coronoid process being an outgrowth from the shaft. The upper epiphysis of the radius consists of the head. These join the shaft about the sixteenth year, the radius preceding the ulna.

Muscles.—Flex the forearm and feel for the tendon of the biceps; this muscle is a supinator of the forearm as well as a flexor. The brachial artery pulsates to the inner side of the

tendon. The muscles arising from the internal condyle are the palmaris longus, pronator radii teres, and common origin of the flexor muscles; those arising from the external condyle are the anconeus, supinator brevis, and common origin of the extensor carpi radialis brevior, extensor communis digitorum, extensor minimi digiti, and extensor carpi ulnaris. The tendon of the triceps can be felt standing out behind; it is inserted into the posterior and upper part of the olecranon, a bursa being interposed. All these muscles are divided in complete excision of the elbow. The superficial extensor muscles on the back of the forearm are those arising from the external condyle and supra-condyloid ridge; the deep extensors are those arising from the shafts of the radius and ulna, *i.e.* the extensor primi internodii pollicis and extensor ossis metacarpi pollicis on the radial; the extensor secundi internodii pollicis and extensor indicis on the ulnar side. All the extensor muscles of the wrist and fingers are supplied by the posterior interosseous branch of the musculo-spiral nerve, except the extensor carpi radialis longior. All the long flexor muscles of the wrist and fingers, with the pronators, are supplied by the median nerve, except the flexor carpi ulnaris and inner half of the flexor propendus digitorum, which are supplied by the ulnar. These facts will be found useful when we come to consider the effects of accidental wounds of the main nerves. The pronator radii teres is inserted into the outer surface of the radius about its middle. This is of importance in the adjustment of fractures of the forearm. The supinator longus is the most superficial muscle on the outer and anterior aspect of the forearm. It extends from the external supra-condyloid ridge above to the base of the styloid process below, and is supplied by the musculo-spiral nerve. The main action of this muscle is to flex the elbow, and secondarily to supinate the hand.

Vessels.—The brachial artery divides into the radial and ulnar arteries opposite the neck of the radius. By extreme flexion of the forearm, the circulation through the brachial may be temporarily arrested. The ulnar artery is the larger

branch, and soon after its origin gives off the interosseous trunk, which divides into anterior and posterior divisions. In amputation of the forearm, just below the elbow, these four arteries usually require ligature. A line drawn from the bend of the elbow to the outer side of the pisiform bone marks the course of the ulnar artery; a line drawn from the bend of the elbow along the outer aspect of the forearm, over the inner border of the supinator longus, corresponds with the course of the radial artery. Opposite the styloid process of the radius, this vessel winds backwards beneath the extensor tendons of the thumb to the back part of the first interosseous space: you must recollect this in marking its entire course.

The anterior interosseous artery lies on the interosseous membrane. It gives a twig to the median nerve, the comes nervi mediani. This little branch may require ligature after amputation. The anterior interosseous artery terminates by passing to the back of the carpus, piercing the interosseous membrane at the upper border of the pronator quadratus. The posterior interosseous artery is found between the superficial and deep layers of extensor muscles. These vessels communicate below with the carpal arches, and through them with the palmar arches.

The veins at the bend of the elbow are like the letter M. The median vein divides into median cephalic and median basilic. The median cephalic vein unites with the radial to form the cephalic vein, the median basilic with the ulnar veins to form the basilic. Bleeding is more safely performed from the median cephalic vein, since it is distant from the brachial artery, and the external cutaneous nerve passes behind it. In practice, you choose the most prominent vein, and this is often the basilic. This vein is separated at the bend of the elbow from the brachial artery by the bicipital fascia, and is crossed by the internal cutaneous nerve.

Nerves.—The skin over the front of the forearm is supplied on the outer side by the musculo-cutaneous nerve, on the inner side by the internal cutaneous nerve. Cutaneous twigs of the

median and ulnar nerves pierce the integument just above the wrist. The back of the forearm is supplied by branches of the musculo-spiral and external cutaneous externally, and the posterior twigs of the internal cutaneous internally. The ulnar nerve can be felt in the groove behind the inner condyle; it may readily be divided in this situation in careless excision of the elbow, or by accidental wounds. In the forearm it lies along the inner side of the ulnar artery. The median nerve is marked by a line drawn from the inner side of the biceps tendon to the front of the wrist just to the ulnar side of the palmaris longus tendon. The musculo-spiral nerve divides into radial and posterior interosseous to the outer side of the biceps tendon. The radial nerve lies on the outer side of the radial artery for its upper two-thirds, and then pierces the fascia about three and a-half inches above the wrist, winding backwards beneath the supinator longus muscle. The posterior interosseous nerve winds to the back of the forearm through the fibres of the supinator brevis, supplying this muscle and all the extensors of the wrist.

Elbow-joint.—The movements permitted in the elbow-joint proper are flexion and extension only. Pronation and supination are performed in the radio-ulnar joints. After excision, these latter movements are to a great extent lost; but flexion may be more free since the coronoid process of the ulnar is removed. The coronoid process is an outgrowth from the shaft, and not a separate epiphysis. It is of small size in children, and hence dislocation backwards of the elbow is a common accident in early life. Should the elbow anchylose from disease, the flexed position is the most useful. There is only one synovial membrane in the elbow, the synovial membrane of the superior radio-ulnar joint being an extension of it. In disease of this joint the elbow is therefore implicated. In cases of synovitis of the elbow, the bulging is felt and seen on either side of the triceps tendon and over the radio-ulnar joint. The bursa over the olecranon is often inflamed, and is the most common cause of cellulitis of the forearm. There

are three bursal sacs about the elbow—the olecranon bursa, the bursa beneath the triceps, and the bursa between the biceps tendon and the tuberosity of the radius. None of these communicate with the joint.

Practical Considerations.—Fractures and dislocations about the elbow-joint are most difficult to diagnose and treat, and their full description belongs to systematic treatises on fractures. You may have seen these rules usefully applied in our out-patient practice :—1. Compare the sound side with the injured. 2. Grasp each condyle, and ascertain whether it is moveable on the shaft. 3. Define the head of the radius, and ascertain that it revolves in its proper position. 4. See that the olecranon moves in the coronoid fossa as on the other side. 5. Ascertain that the joint is not the seat of previous injury or disease. Separation of the lower epiphysis is often partly a fracture. Any fracture running across the lower end of the humerus in early life, is apt to injure the epiphysial line, and may be followed by arrest of growth. Many rules are given for the diagnosis of these injuries. Most of them are not applicable in practice because of the extensive swelling. A careful examination under anæsthetics, comparing the sound with the injured limb, will do more to guide you than the recollection of any theoretical rules.

It has been already explained that backward dislocation of the elbow is a common accident of early life. This injury may be mistaken for a fracture or separation of the epiphysis, for in both there is a projection backwards. In the fracture or epiphysial injury, when you draw upon the forearm, the parts are restored to position, but a crepitus is elicited, and the displacement will recur. In dislocation, the bones "go in" with a snap and remain in place. Further, in fractures, the condyles are moveable on one another, or the shaft of the humerus, and follow the movements of the lower fragment. Fracture of the olecranon, if complete, opens the elbow-joint. The union is generally fibrous. The usual plan of treatment is to place the limb nearly straight upon a long anterior splint,

and approximate the fragments by strapping. This plan has disadvantages, and some surgeons now treat this fracture in the semi-flexed position.

The head of the radius is held in position mainly by the orbicular ligament. It may be displaced forwards or backwards; the absence of the head of the bone in its proper place is the most important sign of the injury. Fractures of the radius are the most common fractures of the upper extremity. The bones being nearer the posterior than the anterior surface of the limb, fracture can be best detected from that aspect. When the fracture of the radius is above the insertion of the pronator radii teres, the upper fragment may be supinated by the biceps and the lower pronated by the pronators. If the bone unites in this position, pronation and supination will be much impaired. In such a fracture, mould a back angular splint of leather or gutta-percha to the arm and forearm, so that the hand is completely supinated, placing also a well-fitting padded splint in front. In fractures of the shaft of the radius in the middle of the forearm, or of both bones, attend to the following points:—1. Use broad, well-padded splints, to reach from the elbow to the fingers, and apply the back splint first. 2. Be careful that the anterior splint does not press upon the veins at the bend of the elbow. 3. The elbow should be flexed, and the limb mid-way between pronation and supination. You cannot be too careful to move the fingers constantly, and to keep a careful watch for œdema and swelling under the splints. I have several times seen sloughing of the skin, and once extensive gangrene of the parts, from neglect of these precautions.

Suppose you had to remove a deeply-seated fatty tumour from the space at the bend of the elbow. An appropriate incision would be made down to the tumour, and you would turn aside the skin and fascia with the external and internal cutaneous nerves and superficial veins. To the inner side would lie the pronator radii teres, to the outer side the supinator longus, beneath the tumour would be the supinator

brevis and brachialis anticus. The biceps tendon would be seen in the middle line, and just internal to it the brachial artery; still more internal one would expect to find the median nerve emerging between the two heads of the pronator radii teres. External to the biceps tendon the musculo-spiral nerve would be found dividing into radial and posterior interosseous branches on the front of the supinator brevis muscle. The posterior interosseous nerve would be seen piercing the supinator brevis.

A man is stabbed in the middle of the forearm down to the interosseous membrane. The knife, after dividing the superficial structures, would pass through the flexor sublimis and flexor profundus digitorum muscles, and may wound the flexor longus pollicis, the anterior interosseous artery and median nerve.

Excision of the elbow can be performed in several ways. In the usual operation, a vertical incision, three inches in length, is carried down to the bone posteriorly, a little to the inner side of the median line. The soft parts are "peeled," from the internal condyle,[1] the knife being kept very close to the bone. The same process is repeated on the other side of the joint. The bones being now bared, the olecranon is cut through with sharp pliers, and this enables you to force the ends of the radius and ulna out of the wound; all the articular surface of these bones is now removed with a fine flat saw. The humerus is next protruded and the articular surface sawn away. All "pulpy" membrane is next most carefully removed with scissors and forceps. Small anastomotic arteries are tied, a drainage tube inserted, and the wound united. Some surgeons keep the arm on a bent splint during repair, others leave it almost straight. The great essential, however, is early passive movement, which should be commenced so soon as ever the wound has healed. Especial care should be taken in dealing with the triceps and anconeus, if these be "peeled" away from the bone they soon form new attachments. In sawing through the lower end of the humerus,

[1] See page 121.

the epiphysial line should be if possible preserved, unless the patient should have reached the age of sixteen years, when growth is to a great extent complete.

One of the best amputations of the arm is by the circular method. One of the best amputations at the elbow is by the long anterior and short posterior flaps. In amputating the forearm, one of the best operations is to fashion skin flaps and divide the muscles by two circular sweeps. Remember that in cutting "skin flaps" you take up fat fascia and subcutaneous tissue, exposing the muscles and keeping the edge of the knife towards them, and not towards the skin. Superficial muscles usually retract more than deep muscles which are attached to the bones beneath. This is why it is better to divide the muscles in the fleshy part of a limb in two sweeps instead of one.

CHAPTER IX.

UPPER EXTREMITY, THE REGION OF SHOULDER AND ARM.

Bony Prominences.—The bony points you must clearly and definitely define in the neighbourhood of the shoulder are, anteriorly, the acromial end of the clavicle; posteriorly, the acromion; externally, the great tuberosity of the humerus. Looking at the subject from in front, you detect a slight hollow beneath the outer third of the clavicle between the pectoralis major and the deltoid muscles. Press the finger downwards and outwards into this concavity, and you feel the coracoid process. Draw a chalk line from the coracoid to the acromion process, and you mark out the position of the coraco-acromial ligament. A knife entered straight under this, midway between the coracoid and acromion, will pass into the shoulder-joint. Especially note that the great tuberosity of the humerus is the most external prominence about the shoulder. Take a rule and lay it along the outer side of the arm, and you will find that it does not touch the end of the acromion. If the tuberosity of the humerus be displaced inwards, it does so. Consequently, undue prominence of the acromion, and a hollow beneath it caused by the disappearance of the prominence of the greater tuberosity, are indubitable signs of dislocation.[1] Now abduct the arm, and press deeply in the outer wall of the axilla. You can feel the round head

[1] I believe that attention was first forcibly drawn to the surgical importance of observing the position of the great tuberosity of the humerus by Professor Humphry.

of the humerus and the lower edge of the glenoid cavity. You can also feel the shaft of the humerus with tolerable distinctness. Examine the outlines of the clavicle. Feel the deltoid tubercle at the middle part of the anterior border of the acromial end, and do not confound it with a bony growth. Feel the attachments of the deltoid and trapezius externally. Note the attachments of the sterno-cleido-mastoid and pectoralis major. The subclavius muscle is beneath the fascia, and does not cause a prominence on the surface of the thorax. If a man were pitched heavily on his shoulder, he would most likely break his clavicle at the junction of the outer and middle thirds. Here the shaft is most curved and slender. This bone is more often broken than any other. The fracture in the young is often of the "green-stick" variety, and is rarely compound unless done by direct violence. In the latter case, the serious complications of tear or wound of the subclavian vein or pleura are possibilities. The usual displacement is confined to the outer fragment, the inner being fixed by the rhomboid ligament. The outer fragment is displaced downwards by the weight of the arm, and inwards by the pectorals, latissimus dorsi, trapezius, and rhomboids. The shoulder is also pointed forwards, and the inner end of the outer fragment backwards. Numerous are the devices and apparatus designed for this fracture, and the subject is one for which I must refer you to appropriate treatises. Unless you can keep the patient in bed on his back, or on a sofa, a large amount of callus will form about the fracture, and you will get permanent shortening. The clavicle may also be broken externally between the conoid and trapezoid ligaments; here little displacement occurs. The bone may also be broken internally close to the sternal end, and then the case is apt to be mistaken for a dislocation. Space will not permit me to deal further with this subject, than to caution you against overlooking a fracture of the clavicle of the "green-stick" variety in a fat infant or child. When a child cries without proper reason on being handled or lifted, it may be rickety, or suffering from a fractured clavicle, often

it is the subject of both affections. The clavicle is developed very early, and the sternal epiphysis joins the shaft at about the twenty-fifth year. Separation of this epiphysis from accident is one of the rarities of surgery.

Muscles.—Map out the deltoid by drawing a figure the shape of a fan. The apex will correspond to the outer side of the shaft of the humerus about the middle, the base to a line running along the whole length of the spine and acromion process of the scapula, and outer third of the acromial end of the clavicle. In the interval between this muscle and the pectoralis major, a blue line will note the course of the cephalic vein, which pierces the costo-coracoid membrane to join the axillary vein. The outline of the infra-spinatus muscle is seen behind, and can be easily mapped out. The supra-spinatus is covered by the trapezius. On raising the arm from the side, you may define the outlines of the sub-scapularis. The latissimus dorsi and teres major muscles are felt in the posterior fold of the axilla. Keeping the arm raised, you will see, in a muscular subject, the digitations of the serratus magnus. The sixth interspace usually lies between the first two visible digitations of the muscle. This muscle arises on the thorax from the eight upper ribs, and is inserted into the whole length of the inner aspect of the vertebral border of the scapula. Continuing the investigation of the muscles of the arm, you can readily delineate the biceps, and can feel the coraco-brachialis on its inner side. Behind you can feel the triceps muscle. The external origin is above, the internal below, and between them is the musculo-spiral groove. Pay especial attention to this latter point. To delineate the outline of the brachialis anticus, attend to the following points. Above, the origin of the muscle embraces the deltoid by two processes quite half-way up the front of the humerus on either side; it extends to the supra-condyloid ridges, being in relation externally with the fleshy mass formed by the supinator longus and extensor carpi radialis longior muscles. Feel these and accurately define their position. If you were to cut deeply

between these muscles and the brachialis anticus, you would find the musculo-spiral nerve. The insertion of the brachialis anticus is into the front of the coronoid process just below the elbow.

Fasciæ.—The costo-coracoid membrane is continuous with the cervical fascia above, and is attached to the clavicle ensheathing the subclavius muscle. Internally, it is attached to the sternum and cartilage of the first rib; externally, it blends with the sheath of the axillary vessels.

Deeply-seated abscess in the neck may point in the axilla, and axillary abscess burrow upwards towards the root of the neck, the pus working havoc in the tissues of the axilla, and fluctuation being concealed by the dense aponeuroses.

The axillary fascia is thus arranged. A strong dense layer passes across the axilla. This is joined above by the fascia which encloses the pectoralis minor, and thus the axillary fascia being drawn up, the arm-pit is rendered concave. Behind, the axillary fascia blends with the sheath of the latissimus dorsi and teres major muscles. Externally, it is continuous with the sheath of the vessels, and with the deep fascia of the arm. The density of this fascia prevents pus from "pointing" in the axilla in cases of deep suppuration. When feeling for enlarged glands in the axilla, bring the arm to the side that this fascia may be relaxed.

The deep fascia of the arm covers the muscles, and is attached to the condyles of the humerus, the olecranon, and coronoid process. Very dense and strong laminæ are attached to the supra-condylar ridges. The external extends as high as the deltoid, it is pierced by the musculo-spiral nerve and superior profunda artery. The internal is attached as high as the coraco-brachialis, and is pierced by the ulnar nerve, inferior profunda and anastomotica magna arteries.

Cutaneous Nerves.—The cutaneous nerves of the shoulder, axilla, and arm are distributed as follows:—From above pass the supra-clavicular and supra-acromial branches of the third and fourth cervical nerves. These pierce the fascia above the

clavicle, and supply the skin of the shoulder as far as the acromion behind, and the integument over the deltoid in front as far as the middle of the arm. Sensation is therefore maintained over these parts in fracture of the spine at the root of the neck. The cutaneous twigs of the circumflex nerve have been already alluded to.[1] The internal cutaneous nerve pierces the fascia with the basilic vein about the middle of the arm on its inner aspect. The nerve of Wrisberg pierces the fascia about the middle of the arm to the inner side of the vessels. The intercosto-humeral nerve, after joining with the nerve of Wrisberg, sends off twigs which pierce the fascia near the back wall of the axilla, and supply the upper and inner aspect of the arm. The external cutaneous nerve pierces the fascia about an inch above the elbow on the outer side of the biceps tendon. There are three cutaneous twigs from the musculo-spiral. One supplies the inner and posterior aspect of the arm. Another pierces the fascia near the outer head of the triceps, and accompanies the cephalic vein. The third pierces the fascia near the insertion of the deltoid, and supplies the back of the arm and forearm nearly to the wrist. These cutaneous nerves communicate so freely, that paralysis of any one of them does not entirely abolish sensation in the skin supplied by it.

Vessels.—Draw a line in chalk from the junction of the middle and inner thirds of the clavicle to the lower part of the anterior axillary fold, just where the coraco-brachialis begins to be prominent; this marks the course of the axillary artery. Draw another line in blue chalk close along the inner border of the preceding; this marks the axillary vein. The brachial plexus lies to the outer side of the first part of the artery. The three cords of the brachial plexus surround the second part of the artery. One cord is to the outer side, one to the inner, and the other posterior. The third part of the artery has the terminal branches of the brachial plexus thus arranged. Outside lie the median and musculo-cutane-

[1] Chapter VII., page 119.

ous nerves; inside, the ulnar, internal cutaneous, and lesser internal cutaneous; behind, the musculo-spiral and circumflex nerves. Particularly note that the third part of the artery is covered merely by skin and fascia; it may be compressed here against the upper end of the humerus. The first part of the artery can also be compressed against the first rib in the infra-clavicular fossa, but only with difficulty. The branches of the first part of the artery are the superior and acromial thoracic; of the second, the long and alar thoracic; of the third, the sub-scapular, the anterior and posterior circumflex. Draw a line from the upper end of the outer wall of the axilla, along the axillary border of the scapula to its lower end, and you indicate the course of the important sub-scapular artery. The arteries about the scapula are as follows:—In the sub-scapular fossa, the sub-scapular, supra-scapular, and posterior-scapular arteries; in the supra-spinous fossa, the supra-scapular and posterior-scapular arteries; in the infra-spinous fossa, the posterior-scapular, dorsalis scapulæ, and supra-scapular arteries. The three main vessels that furnish blood to a tumour of the scapula are the sub-scapular, the supra-scapular, and posterior-scapular arteries.

Draw a line from the axilla a little nearer its anterior than its posterior wall, opposite the lower border of the teres major, to a point opposite the neck of the radius in front of the elbow. This is the course of the brachial artery. The vessel lies along the inner margin of the biceps and coraco-brachialis muscles, is accompanied by venæ comites, and has the main nerves in relation with it. The median nerve crosses the artery obliquely from without inwards; the ulnar nerve lies to its inner side; and so does the internal cutaneous. The musculo-spiral nerve is behind it in the upper third. Occasional muscular slips cross the artery from the latissimus dorsi, and from the pronator radii teres muscles. The last-named muscle, it will be remembered, has rarely a third origin, which arises from the supra-condyloid process, a hook-like bony prominence above the internal condyle, beneath which,

in the cat, pass the median nerve and the ulnar artery. The superior profunda branch accompanies the musculo-spiral nerve in the musculo-spiral groove. The basilic vein pierces the fascia about the middle of the arm. In its course it lies over the artery between the layers of superficial fascia. Remember this when cutting down upon the brachial artery. The cephalic vein courses up the outer aspect of the arm, passes between the pectoralis major and deltoid to pierce the costo-coracoid membrane.

Main Nerves.—Especially learn to map out the course of the musculo-spiral nerve. Begin your chalk mark behind the third part of the axillary artery, and carry it backwards round the humerus in a sloping downward course just below the deltoid insertion, between the two heads of the triceps muscle. The line should come to the front about three and a-half inches above the external condyle; from here to the outer side of the elbow its course is straight, lying between the brachialis anticus and the supinator longus. The nerve divides into radial and posterior interosseous. You can sometimes feel the musculo-spiral nerve by pressing deeply at the back of the arm. The median nerve crosses the brachial artery from without inwards about its centre, and passes into the forearm between the two heads of the pronator radii teres muscle. The ulnar nerve lies along the inner side of the artery all the way down; it is some distance from it below, and pierces the internal septum just above the elbow, to get to the back of the internal condyle. The supra-scapular nerve passes beneath the transverse ligament of the scapular notch.

Shoulder-Joint.—The muscles above the shoulder are the supra-spinatus and deltoid. Externally are the tendons of the infra-spinatus and teres minor; internally, the sub-scapularis is attached to the lesser tuberosity. Below is the scapular head of the triceps. Note that, by rotating the bone forcibly outwards and inwards, the tendons of the muscles attached to the tuberosities are respectively brought into prominence, and

can be readily divided in excision of the joint. The long tendon of the biceps traverses the joint, and prolongations of synovial membrane pass along it. Beneath the sub-scapularis and infra-spinatus there lie bursæ of variable size, usually communicating with the joint. The large bursa under the deltoid is often multilocular, and does not communicate with the joint. Any of these bursæ may form cystic swellings of great size, especially in "chronic arthritis" of the shoulder. The capsular ligament is loose and lax. It is strengthened above by the coraco-humeral ligament. The long tendon of the biceps and the coraco-humeral ligament prevent upwards displacement of the head of the humerus. There is one synovial membrane in the joint which communicates with bursal sacs, as above mentioned. Remember that the humerus moves upon the scapula in every direction; this is of importance to those who practise "massage" and movements of this joint after too prolonged rest. In dislocation, the head of the bone tears through the capsule inferiorly as a rule. The upper epiphysis of the humerus consists of the head and tuberosities, which unite into one piece about the fifth, and join the shaft about the twentieth year. In separation of the epiphysis, therefore, the great tuberosity belongs to the upper fragment, and maintains its position with regard to the acromion. The line of separation is, however, higher than the surgical neck. The common fracture of the humerus, in the vicinity of the shoulder, is through the surgical neck, about an inch below the tuberosities. Fracture of the anatomical neck is more often talked of than seen.

Acromio-clavicular Joint.—There are usually two synovial membranes in this articulation. The clavicle may be partially or entirely dislocated upwards on the acromion. It can hardly be displaced downwards, on account of the direction of the articular surface of the adjacent bones. Examine this carefully in the articulated skeleton. The outer end of the clavicle may be unduly large, and then, after a blow or sprain, the diagnosis of dislocation is erroneously arrived at. When this

joint is displaced, with the clavicle riding upon the acromion, I know of no apparatus that will keep the parts in position sufficiently to maintain permanent reduction. Read this subject in your text-books, and you will see that the same difficulty probably occurs to the mind of your surgical author.

Practical Considerations.—In dislocations of the shoulder, the leading symptom is the flattening beneath the acromion, caused by the absence of the great tuberosity from its most prominent position. Fracture of the anatomical neck of the humerus, with displacement, is among the rarities of surgery; but, when it occurs, it is most difficult to accurately diagnose it. In disease of the shoulder, with caries, the pus usually burrows beneath the muscles round the joint, getting into the bursæ or coursing along the muscles, and pointing at some distance from the joint. Thus, the abscess may point in the middle of the arm, in the venter of the scapular, or the infraspinous fossa. A discharging sinus in these positions is exceedingly likely to be mistaken for necrosis of the scapula or shaft of the humerus. Bursal swellings also may form at some distance from the joint, and these may be of large size. Examine the shoulder-joint carefully in all these conditions for disease of the articulation. In excision of the shoulder, the knife enters beneath the coraco-acromial ligament, and is carried down the shaft through the anterior fibres of the deltoid for three and a-half inches. This incision should avoid the cephalic vein, and reach the bone; the anterior circumflex artery will be divided, and bleeds furiously. In reducing a dislocation of the shoulder by means of a "clove-hitch" round the humerus above the condyles, remember that you draw upon the biceps and triceps also, and thus drag down the scapula and defeat your own object. The heel in the axilla, or a counter-extending band fixed behind the head of the patient, obviates this to some extent.

When the deltoid muscle is paralysed from such conditions as chronic rheumatic arthritis of the shoulder, long fixation of the joint, injuries to the circumflex nerve, or severe contusions,

dislocation of the humerus is closely simulated; there is flattening beneath the acromion, but the tuberosity of the humerus still retains its normal position.

In amputating through the arm, divide the muscles in two sweeps, since the brachialis anticus, being fixed to the bone, retracts less than the biceps and parts of the triceps. In amputating at the shoulder, have a skilled person to control the subclavian-artery; after cutting the large deltoid flap and disarticulating, grasp the axillary vessels between your finger and thumb before dividing them.

To make an incision into the axilla, for the removal of a tumour or the opening of an abscess, cut along the inner wall of the space parallel to the long thoracic artery, and commence the incision at the apex. If you cut outwards you wound the axillary vein; if you cut posteriorly you may divide the subscapular artery. The axillary vein is merely covered by skin and fascia, and, when engorged with blood, it comes into sight much sooner than you expect. It is too often pricked or opened by those who use a knife incautiously in the axilla. This vessel bleeds freely from both ends when divided, for its sheath is adherent to the fascia which holds the vessel open. In making incisions upon the humerus for acute periostitis or necrosis, select the back of the arm below the musculo-spiral groove. The ulnar nerve may be divided by accident in any part of its course, and any of the divisions of the brachial plexus may be injured in the neck by severe blows, or wrenches of the shoulder, or pressed upon by exostoses from the first rib or vertebra. The symptoms are, then, often very puzzling unless you know well the distribution of the nerves. Note especially that shooting pain down the inner side of the arm is a frequent sign of thoracic aneurism or growth, on account of the connection of the nerve of Wrisberg with the second intercostal nerve. The brachial artery can be commanded in the arm by pressing it against the humerus from within outwards. If you cut down upon it in the middle third of the arm, you must avoid the basilic vein, and you will find the vessel with veins

on either side of it, and the median nerve crossing it from without inwards. The ulnar nerve lies to the inner side. If the third part of the axillary or upper part of the brachial be tied, the circulation is carried on through ascending branches of the superior profunda anastomosing with the circumflex arteries. If the brachial be tied in the middle of the arm, the superior profunda anastomoses below with recurrent branches of the radial, ulnar, and posterior interosseous arteries.

CHAPTER X.

LOWER EXTREMITY, THE FOOT, ANKLE, AND LEG.

Bony Prominences.—The external malleolus is placed on a lower level than the internal, and in a line posterior to it. Therefore, in Syme's amputation through the ankle, the incision should run from the point of the external malleolus to a point below and behind the internal. The head of the astragalus can be felt in front of the ankle between the malleoli when the foot is well extended; often a bursa lies over it. It lies much nearer the ankle-joint than is generally supposed. In front of the head of the astragalus is situated the scaphoid. The tuberosity of this bone projects on the inner side of the foot. Immediately in front of the scaphoid lies the internal cuneiform bone, and next in order, the base of the metatarsal bone of the great toe. Continuing your examination along the inner side of the toe, you define the head of the metatarsal bone, and the sesamoid bones on either side of it. By deep pressure on the outer side of the os calcis, the peroneal tubercle can be detected; in front of it is the cuboid bone, and still more forward the base of the fifth metacarpal bone. About an inch below the internal malleolus you can feel the projection of the "sustentaculum tali." The lower epiphyses of the tibia and fibula unite to the shaft about the twentieth year. The inner surface of the tibia is practically subcutaneous, and fracture can be detected here with general certainty. The narrowest part of the tibia is at the junction of the middle and lower thirds. Here fracture usually takes

place. Both bones of the leg are more usually broken than either singly. The lower fragments usually project upwards and backwards; the upper fragment of the tibia makes a sharp projection forwards and inwards, often coming through the skin. When the fibula is broken in its shaft, the tibia forms a sufficient splint. "Potts' fracture" is a fracture of the fibula about three inches above the malleolus. The internal lateral ligament of the ankle is torn, or the end of the malleolus broken off. The ankle is dislocated outwards, and the foot forcibly everted. This accident is difficult to deal with in practice, and you must study it carefully because of its frequency. In "setting" a fracture of the leg, attend to the following points. Make an assistant well flex the leg on the thigh, to relax the calf muscles. Manipulate the parts into as good position as possible. See that the foot is at right angles to the leg, and that the great toe, patella, and anterior-superior iliac spine are in the same line, so that no undue rotation of the fragments is possible. Do not bandage over the immediate seat of fracture. Should there be much tendency to displacement, place the leg in a swinging cradle, and keep the knee well bent.

Tendons and Muscles.—Extend the foot upon the leg, and the tendons in front of the ankle start into relief. Observing them from within outwards, you can feel and see the tibialis anticus tendon; traced into the foot, this structure is attached to the internal cuneiform bone, and base of the metatarsal bone of the great toe. The extensor proprius pollicis next claims attention. It passes to the terminal phalanx of the great toe. The extensor communis digitorum can be seen and felt with the peroneus tertius. The latter passes to the base of the fifth metatarsal. Behind the fibula lie the peroneus longus and brevis tendons, the peroneus longus being anterior. The peroneus brevis passes to the fifth metatarsal bone; the peroneus longus passes behind it to the base of the metatarsal of the great toe, crossing the sole obliquely from without inwards through the cuboid groove. By everting the foot,

the tendon of the tibialis posticus can be felt, close to the inner border of the tibia, which is the guide to it. In an infant the inner border of the tibia is nearly midway between the front and back of the leg. Tracing the posterior tibial tendon into the foot, its main insertion would be found at the tuberosity of the scaphoid. Here it is somewhat expanded, and supports upon it the head of the astragalus. Proceeding externally, the next tendon is that of the flexor longus digitorum, and in a groove behind the tibia close to the tibio-fibular articulation is the tendon of the flexor longus pollicis. The tendo Achillis is inserted into the lower part of the calcaneum, and a bursa is found beneath it above its insertion. The plantaris tendon lies to its inner side. Synovial sheaths invest each of these tendons. That of the posterior tibial tendon is particularly distinct, and in close relationship with the ankle. The peroneal tendons have a single synovial sheath, which is prolonged along both of them, above and below the peroneal tubercle. Any of these tendons may be displaced by violence, especially the peroneus longus. Tenotomy of the Achillis tendon is best performed one inch above its insertion at its narrowest part; the posterior tibial tendon may be divided two inches above the inner malleolus, so as to avoid its synovial sheath. The tibialis anticus is tenotomised below the anterior annular ligament, the knife being introduced from the outer towards the inner side, away from the artery. Make the subject extend the toes forcibly, and the origin of the extensor brevis digitorum shows itself just in front of the ankle on the outer aspect of the foot. I have frequently heard students pronounce the swelling thus revealed to be a bursa or chronic abscess.

The muscles of the first layer of the sole are the abductor pollicis, flexor brevis digitorum, and abductor minimi digiti. The second layer are the flexor accessorius and lumbricales, with the flexor longus digitorum and flexor longus pollicis. The third layer are the short and deep muscles taking origin from the anterior bones of the foot. They are the flexor

brevis pollicis, flexor brevis minimi digiti, abductor pollicis, and transversus pedic. The fourth layer is formed by the three plantar interossei. In the various amputations of the foot, if you know the joints through which the knife passes and the general arrangement of the muscles, it will prove a great help to your memory in mentioning the structures necessarily divided.

The muscles on the front of the leg are the tibialis anticus, extensor proprius pollicis, extensor longus digitorum, and peroneus tertius, with the peroneus longus and brevis externally. The superficial muscles on the back of the leg are the gastrocnemius soleus and plantaris. The deep calf muscles are the popliteus above, the flexor longus pollicis on the outer side, the flexor longus digitorum on the inner, the tibialis postieus between them. All these muscles, with the exception of the popliteus, would be divided in an amputation of the middle of the leg.

Plantar Fascia.—This strong, dense membrane closely resembles the fascia in the palm, being narrow at its origin from the inner tubercle of the os calcis, and broader towards the toes. It splits up into five slips opposite the heads of the metatarsal bones. These slips blend with the sheaths of the tendons at the side of the toes. In the intervals the lumbricales and digital vessels show, being covered over by a thin membrane prolonged from the fascial divisions. Other prolongations pass to the deep transverse ligament of the metatarsus, and to the superficial transverse ligament found in the "webs" of the toes. The central portion of the fascia covers in the flexor brevis digitorum muscle. Septa pass into the sole separating this muscle, from the abductor pollicis on the inner side and the abductor minimi digiti on the outer. These two muscles are covered by the lateral portions of the fascia, which extend from the os calcis behind to the metatarsals in front. The outer portion is the strongest. These lateral portions of the plantar fascia are continuous with the fasciæ over the dorsum of the foot.

This fascia assists in maintaining the arch of the foot, and is stretched in bad cases of "flat foot." Abscess beneath it has the same serious consequences, and needs the same treatment as in the hand. In the disease termed perforating ulcer of the foot, pus accumulates and burrows towards the dorsum, being confined by the fascia and thick corneous integument of the sole. This fascia is often contracted in talipes equino varus, and talipes cavus, in which affections various bands of it need division. This should be done as near its origin as possible. The deep fascia of the leg forms a strong and dense investment for the muscles, and is not continued over the subcutaneous surface of the tibia. Behind, it is continuous above with the fascia lata, and is strengthened by prolongations of the biceps, sartorius, gracilis, and semi-tendinosus tendons. It covers the popliteus, and forms a broad sheet beneath the gastrocnemius and soleus, separating them from the deep muscles, and the posterior tibial vessels. This layer of fascia is very dense near the ankle. On the front and outer aspect of the leg the fascia is dense and thick superiorly, where it gives origin to the muscles. It is attached to the head of the tibia and the head of the fibula. Below, the deep fascia of the leg is continuous with the annular ligaments, and is attached to the malleoli. Septa pass from this fascia separating various groups of muscles from each other.

The density of this fascia explains the ease with which sloughing or gangrene of the leg takes place in excessive inflammatory effusions, or cases of wound of one of the deep arteries with great extravasation of blood. Deep abscess of the calf is a most serious affection, and if not soon opened the pus "burrows" extensively beneath the fascia, leading to destruction of the muscles.

Arches of Foot.—The antero-posterior arch of the foot has its summit at the articulation between the astragalus and scaphoid, the posterior pillar of the arch is formed by the calcaneum and astragalus, the anterior by the scaphoid,

cuboid, cuneiform and metatarsus. The outer part of the arch would be formed by the os calcis behind, the cuboid and the outer metatarsals in front. The inner part of the arch has the os calcis and astragalus behind the scaphoid, and the cuneiform bones in front. The head of the astragalus is supported upon the expanded tendon of the tibialis postieus and inferior calcaneo-scaphoid ligament, which in man is formed of yellow elastic tissue. The calcaneo-cuboid ligaments and plantar-fascia stretch across the arch like the strings of a bow, and prevent it from "flattening out." When these structures relax or are unduly strained, the head of the astragalus sinks downwards, and the muscles, fasciæ, and nerves of the sole are stretched; "Flat-foot" ensues, with much pain and aching about the ankle and foot. This affection is common in errand-boys, shop attendants, and waiters. The transverse arch of the foot is formed by the cuneiform bones at their junction with the metatarsus; these bones form a distinct concavity, and the transverse ligaments assist in its maintenance.

Joints.—The ankle-joint is formed by the astragalus articulating with the tibia and fibula. There is only one synovial membrane, the inferior tibio-fibulæ joint being a prolongation of it.

When this synovial sac is distended with fluid, swelling and fluctuation are evident beneath the extensor tendons in front, and on either side of the tendo Achillis behind. The ankle-joint is on a level with a line drawn across the middle of the two malleoli, and the principal movements permitted in it are flexion and extension. In extreme extension, the narrowest part of the astragalus is brought between the malleoli, and slight lateral movements are possible. The amputations of Syme and Pirogoff are performed through this articulation. The transverse tarsal joint is situated between the os calcis and astragalus behind, and the cuboid and scaphoid in front. The line of this joint is much nearer to the front of the ankle than is usually imagined. Place your thumb on the tuberosity

of the scaphoid, and your finger on the cuboid. A line drawn from the one to the other behind your finger and thumb would mark the joint. Chopart's amputation is performed through this articulation, and the movements of inversion and eversion of the foot are here chiefly performed. Inversion of the foot is associated with extension of the ankle, eversion with flexion. To indicate the position of the joints between the tarsus and metatarsus, draw a curved line across the dorsum of the foot from the base of the fifth metatarsal bone to the base of the first. The base of the second metatarsal sinks backwards between the cuneiform bones, so that the line is not quite straight. Hey's amputation is performed through these joints, though, if you read his work, you will find that he occasionally used the saw.

The metatarso-phalangeal joints lie a full inch behind the "web" of the toes. In amputating any of the toes, preserve the head of the metatarsal bone if possible, so as to preserve the integrity of the transverse ligament of the metatarsus. This important structure binds the heads of all the metatarsals together; in the hand, the corresponding structure is not attached to the metatarsal of the thumb.

Synovial Membranes and Bursæ.—There are six synovial membranes in the tarsus. The following points regarding some of them are of interest. The anterior astragalo-calcanean membrane is prolonged between the head of the astragalus and the scaphoid. Consequently disease of one of these joints implicates the other. The synovial membrane between the scaphoid and cuneiform bones is very extensive. It is prolonged between the cuneiform bones, and to the tarso-metatarsal joints of the three middle toes, consequently disease of this membrane is a very extensive and important matter. The joint between the great metatarsal and internal cuneiform has a single synovial membrane. There are also separate synovial sacs between the cuboid and calcaneum behind, and fourth and fifth metatarsals in front. Lastly, there is a separate membrane for the posterior astragalo-

calcaneal joint. Bursæ may be developed over all the prominent bony points about the foot. An inflamed bursa over the first metatarso-phalangeal articulation is termed a bunion. There is an important deep bursa between the tendo Achillis and the tibia; this, when inflamed and suppurating, may be mistaken for abscess and necrosis. The synovial sheaths which accompany the tendons round the ankle may be implicated in wounds, the escape of synovial fluid does not therefore necessarily mean that the ankle-joint is opened. In deformities of the foot, very large and semi-solid bursal swellings are found over the displaced bones.

Vessels.—The posterior tibial artery divides at the inner ankle into internal and external plantar. The external plantar is the larger, and forms the plantar arch. Mark out its course by drawing a curved line from the inner ankle to the base of the fifth metatarsal bone, and then across the foot to the first interosseous space, where the vessel joins with the large communicating branch from the dorsalis hallucis artery. The external plantar artery crosses the foot opposite the bases of the metatarsal bones, not opposite their heads, and is deeply placed beneath the fascia, short and long flexor tendons, and abductor pollicis muscle; its branches are digital. The internal plantar artery is marked by drawing a line from the inner ankle along the inner side of the foot to the great toe. The arterial branches about the heel are the termination of the peroneal, the internal calcanean from the posterior tibial, and the external and internal malleolar from the anterior tibial. These are the vessels which nourish the flap in Syme's amputation. The dorsalis pedis artery is marked by a line drawn from the front of the ankle along the dorsum of the foot to the base of the first interspace, not to the web of the toes. This line must be to the outer side of the extensor proprius pollicis tendon. The vessel, terminates as the long dorsalis hallucis branch to the great toe, and sends a communicating twig through the first interosseous space into the sole of the foot. The tibialis anticus

and extensor proprius pollicis lie to its inner side, and it is crossed by the innermost tendon of the extensor brevis digitorum. The anterior tibial artery comes to the front through an aperture in the interosseous membrane in the upper third of the leg on its outer aspect, about an inch below the head of the fibula. Its course is marked by a line drawn on the outer aspect of the leg, from the above point to the front of the ankle. Make the model set the tibialis anticus muscle into action, and draw the line along its outer side. The artery lies upon the interosseous membrane, tibia, and ankle-joint. The nerve lies to its outer side, and often rests upon it in the middle of its course. It is crossed by the extensor proprius pollicis tendon. The origin of the anterior tibial artery for about half-an-inch, lies behind the leg, between the heads of origin of the tibialis posticus.

Map out the course of the posterior tibial artery by a line drawn from the lower border of the popliteus muscle two inches below the knee-joint, to the inner ankle, below and behind the inner malleolus. It is covered by the mass of the calf muscles and the deep fascia of the leg. The nerve lies first to its inner, and crosses to the outer side. To tie the vessel in the middle of its course, an incision three inches long is made along the inner side of the leg, in its middle third, about half-an-inch from the inner border of the tibia. The tibial origin of the soleus muscle is exposed, and must be divided, as also the deep fascia of the leg. The peroneal artery comes off from the posterior tibial about three inches below the knee. Its course would be denoted by a line drawn along the back of the fibula to the posterior aspect of the outer ankle, where it anastomoses with the malleolar and calcanean arteries. A large and important branch, the anterior peroneal, passes beneath the interosseous membrane just above the ankle, and over the front of the foot on its outer side.

Practical Considerations.—Either of the tibial arteries may be injured in fractures of the bones of the leg. In stabs

and bullet wounds of the region of the calf, it is often exceedingly difficult to ascertain which vessel is injured. Thus the anterior tibial artery may be wounded behind the interosseous membrane, where it comes off from the popliteal. A stab from the front of the leg has been known to pass through the interosseous membrane and wound an artery behind it. The surgeon will therefore reflect before he commits himself to a dissecting operation, in cases of hæmorrhage from punctured wounds in these regions. In an amputation through the middle of the leg, you would find the anterior tibial artery on the interosseous membrane between the tibialis anticus and extensor longus pollicis. The nerve would lie to its inner side. The posterior tibial artery would be found between the superficial and the deep calf muscles, the nerve being to its outer side. The peroneal would be found close to the fibula in the substance of the flexor longus pollicis muscle.

The internal saphenous vein passes in front of the inner malleolus, but behind the knee, in its course to the saphenous opening. It has communicating twigs with the deep veins. There are numerous valves in this vein, and a very distinct pair of these structures is situated at the saphenous opening. As this vein passes up the thigh, it lies over the course of Hunter's canal, and may be easily wounded in an incautious incision to tie the femoral artery. The short saphenous vein passes behind the outer malleolus, and empties itself into the popliteal vein; it pierces the deep fascia in the centre of the calf, just where the tendons of the gastrocnemius become muscular, whereas the long saphenous vein pierces the deep fascia at the saphenous opening. This vein also contains numerous valves, one pair being found at its embouchure.

Nerves.—The cutaneous nerves of the foot and leg are as follows:—the internal saphenous nerve pierces the fascia behind and below the knee on its inner aspect, between the tendons of the gracilis and semi-tendinosus. It supplies the skin area of the inner side of the leg and foot, as far as the ball of the great toe, not to the end of it. The external or

short saphenous nerve is formed by two twigs (communicantes peronei et poplitei), which pierce the fascia separately, just where the gastrocnemius becomes muscular. The single trunk thus formed supplies the skin of the calf on its outer aspect, and the outer side of the foot as far as the end of the little toe. The dorsum of the foot and toes are supplied with sensation as follows: the musculo-cutaneous nerve pierces the fascia in the lower third of the leg on its outer aspect. In a thin foot, on adduction, this nerve can often be seen as a subcutaneous cord, and must not be mistaken for a tendon. The branches of this nerve supply the inner side of the great toe, and the sides of all the other toes, with the exception of the great and second toes, which are supplied by the anterior tibial nerve, and the outer side of the little toe, which is supplied by the short saphenous.

The external popliteal nerve winds to the front of the leg, round the fibula, beneath its head, in the substance of the peroneus longus muscle. It there divides into anterior tibial and musculo-cutaneous. The anterior tibial nerve, therefore, does not accompany the artery over the interosseous membrane.

Practical Considerations.—Suppose the external popliteal nerve to be accidentally divided. The skin and muscles supplied by the anterior tibial and musculo-cutaneous nerves would be paralysed. Thus sensation would be lost or modified over the dorsum of the foot, and all the toes, with the exception of the outside of the fifth, to which the short saphenous nerve is distributed. All the anterior group of tibial muscles would be paralysed, and also the peronei; consequently, the foot would be inverted by the tibialis posticus, and the heel drawn upwards by the tendo Achillis, producing talipes-equinovarus.

The anterior and posterior tibial nerves are seldom wounded by direct stabs, but may be injured or implicated in fractures of the bones of the leg. If the internal popliteal nerve were divided, all the muscles of the calf and the flexors of the toes would be paralysed. Consequently the heel could not be

drawn up, or the foot extended at the ankle. Flexion of the toes would be done away with, and lateral movements also, all the short muscles of the sole being paralysed. Sensation would be impaired over the sole and lower part of the back aspect of the leg.

Before leaving the consideration of this part of the body, study carefully from your text-book the method of performing the ordinary amputations of the foot and leg, and consider the structures divided in each. As an example, let us enumerate the structures divided in Syme's amputation. In the heel incision would be cut the skin, fascia, and external saphenous vein and nerve. Below the inner malleolus would be divided the tibialis posticus, flexor longus digitorum, posterior tibial vessels and nerve, and the flexor longus pollicis. Below, the external malleolus would be cut, the peroneus longus and brevis. As the knife traverses the sole, it passes through a dense pad of fibrous tissue and fat, and should strike the bone just behind the origin of the short muscles of the sole. The dorsal incision divides the skin and fascia, the internal saphenous vein and nerve, the tibialis anticus, the extensor proprius pollicis, extensor longus digitorum, and peroneus tertius. The anterior tibial vessels and nerve are divided external to the extensor longus digitorum; the musculo-cutaneous nerve and anterior peroneal artery still more externally. The foot being depressed, the anterior ligament of the joint is opened, and the lateral ligaments are divided from within, cutting downwards on either side. Continuing forcibly to depress the foot, the surgeon dissects down the heel flap, keeping hard upon the bone, and dividing the tendo Achillis and plantaris. The malleoli are now sawn off, but the cartilage on the under surface of the tibia may be left intact, so as not to open the cancellous tissue of the tibia. The practice of different surgeons differs in this respect. In peeling the heel flap from the bone, the surgeon divides the radicles of the vessels which nourish it. These are the internal calcanean from the posterior tibial, the termination of the peroneal, and the external

and internal malleolar. In making the heel flap, the foot should be held at right angles to the leg, and the base of the flap made as broad as possible. If the reverse is the ease, and a elumsy eup-shaped flap is formed with a narrow base, it will probably slough. The posterior end of the os ealeis is developed by a separate epiphysis, whieh appears at the tenth year, and joins about the sixteenth. In operating upon young people, you must be eareful not to separate this with the knife, or the dissection of the flap from the bone will be diffieult. The struetures divided in Pirogoff s amputation are similar to those cut in Syme's, with this exeeption—the heel ineision being earried further forwards under the sole, the os ealeis is sawn through instead of the tendo Aehillis being divided, and the first layer of the short museles of the sole, with the plantar vessels (instead of the posterior tibial), are eut. The tibia and fibula are sawn through just above their eartilaginous artieular surfaee.

CHAPTER XI.

KNEE AND THIGH.

Bony Landmarks.—Define the outlines of the patella. Note that it moves on the condyles of the femur, and does not articulate with the tibia, from which it is separated by a cushion of fat. Should the patella be floated up by fluid, it does not impinge upon the femur on pressure, and this is the great test of presence of fluid in the joint. Should you first displace fluid and then reach the patella, it becomes equally certain that there is fluid outside the joint, as in suppurating bursa. The patella is often fractured obliquely by muscular action, and the fragments are widely separated. When this occurs, the knee-joint is opened by the fracture. But the patella may be fractured, and the knee-joint not opened, the cartilage under the bone being intact. The common dislocation of the patella is outwards. This may be congenital in origin, or due to a heavy blow on the inner side of the knee. The patella is invested superficially by a strong aponeurosis, which is attached to the margins of the bone, and is derived from the fascia lata. In bursal abscess this fascial aponeurosis guides the pus downwards and backwards, the joint being seldom implicated. The quadriceps is inserted into the patella above, the aponeurosis of the vasti muscles externally and internally. The vastus internus sends muscular fibres to the patella, so that the knee is partially covered by muscle on its inner side.

The tubercle of the tibia is situated immediately below and in front of the knee. The patellar tendon is inserted into the

lower part of the tubercle, and is separated from it above by a bursa. Just above this bony prominence is the level of the knee-joint and the synovial membrane. Feel next the external and internal tuberosities of the tibia. The semi-membranosus is inserted into the inner, the ilio-tibial band into the outer, tuberosity. The upper epiphysis of the tibia joins the shaft at about the twenty-fifth year. The cancellous tissue of the upper end of the tibia may be the seat of ostcitis, necrosis, abscess, and malignant growths. All of these conditions may be associated with expansion of the bone.

Next feel the head of the fibula, below and externally, and define the biceps tendon passing to it, divided at its insertion by the external lateral ligament. By very firm manipulation you can make the head of the fibula move upon the tibia. Above the inter-articular line you can feel the inner and outer condyles of the femur. Above the inner condyle, by deep pressure with the knee flexed, you can detect the tubercle for the insertion of the tendon of the adductor magnus. This is a common position for exostosis. The lower epiphysis of the femur joins the shaft at about the twenticth year. It is occasionally separated by violence.

Muscles.—The large mass of museles on the front of the thigh is formed by the rectus and crureus in the middle line, and the vasti on either side.

The sartorius is mapped out by a ribbon-shaped figure extending from the anterior-superior spine of the ilium to the inner side of the shaft of the tibia, below the level of the inner tuberosity. The tensor vaginæ femoris extends from the outer lip of the iliac crest anteriorly to the fascia in the middle of the thigh, and thence is continued downwards as the ilio-tibial band. The most superficial muscle on the inner side of the thigh is the gracilis. Mark its origin by drawing a line for two and a-half inches along the inner margin of the pubic and ischial rami. Then sketch it down the inner side of the thigh, becoming thin and tendinous, for four inches, before it is inserted into the shaft of the tibia below the inner

tuberosity. The tendon of the adductor longus is plainly to be felt leading to the spine of the pubes: this will be again referred to. Turn the subject on his face, and request him to flex the leg on the thigh forcibly. The "hamstring" tendons start into relief. On the outer side of the joint you will feel the tendon of the biceps, and, external to this, the ilio-tibial band. Between these structures you may cut safely in opening a deeply-seated popliteal abseess. Feel for the external popliteal nerve close to the inner side of the biceps tendon, not running parallel to it, but approaching it at an aeute angle, and passing beneath the tendon to wind round the fibula. On the inner side of the space you first feel the tendon of the semi-tendinosus thin and eord-like, next the tendon of the gracilis, and more internally and less distinctly the sartorius. The semi-membranosus is broad and membranous here, and not a rounded tendon; it ean be felt on deep pressure between and below the tendons of the gracilis and semi-tendinosus. Note the arrangement of these tendons at their insertion into the inner side of the shaft of the tibia. The sartorius is most anterior, and the gracilis is inserted above the semi-tendinosus. Extend the leg, and you will see a swelling below the popliteal spaee eaused by the popliteus muscle. This musele would show more, but it is bound down by a dense fascia, largely derived from the semi-membranosus muscle. Outline the popliteus by drawing a somewhat triangular figure, the apex corresponding to the back of the outer condyle of the femur, the base to a line about three inches long on the inner border of the tibia, just below its inner tuberosity.

Lastly, abduct the thigh, and mark out the adduetor longus and brevis muscles by triangles—their apices corresponding to the attachment of these muscles to the pubic and ischial rami, their bases to the inner aspeet of the back of the femur.

Surgical Relations of important Muscles.—The surgical relations of the sartorius are as follows:—It is covered by the integument, superficial fascia, fascia lata, branches of the

cutaneous nerves, and the internal saphenous vein, which crosses it near the knee. It covers over the iliacus, psoas, pectineus, rectus, adductor longus and magnus, anterior crural and long saphenous nerves, vastus internus, gracilis, internal lateral ligament of the knee, and inner side of the tibia. It crosses the femoral sheath at the apex of Scarpa's triangle, forming the outer boundary of that space. The femoral artery is in relation for a short distance with its inner border. The tendon of insertion is anterior to the gracilis and semi-tendinosus, and a bursa is interposed.

The adductor longus is covered by the fascia lata, and has anterior to it the sartorius and the femoral vessels at its insertion into the femur. Behind it lie the adductor brevis and magnus, the anterior branches of the obturator nerve, and the profunda femoris vessels. By its outer border it is in relation with the pectineus, and forms the inner boundary of Scarpa's triangle; by its inner border it is in relation with the gracilis.

The popliteus muscle is covered superficially by the deep fascia of the leg, and an expansion of the semi-membranosus muscle. Its tendon of origin passes beneath the external lateral ligament and the biceps. The above-named fascia separates the surface of the popliteus from the gastrocnemius, plantaris, internal popliteal nerve, popliteal artery and vein It lies upon the back of the tibia and tibio-fibular joint. A process of the synovial membrane of the knee is prolonged beneath the muscle on the outer side.

Fascia Lata.—The deep fascia of the thigh is one of the most important structures in the body from a surgical point of view. Posteriorly, it is attached to the sacrum and coccyx, the ramus and tuberosity of the ischium and great sacro-sciatic ligament, the external lip of the crest of the ilium and its anterior-superior spine; anteriorly, to the whole length of Poupart's ligament and the spine of the pubes, and to the pubic crest and its pectineal line. Below, it has firm attachments to the condyles of the femur, the sides of the patella, the inner and outer tuberosities of the tibia and head of the fibula. In the

popliteal space it is continuous with the deep fascia of the leg. Numerous strong and dense septa pass down from this fascia to the bones, separating the muscles from each other. The gluteus maximus is enclosed by two dense layers, which unite at its lower border into a dense aponeurosis. This sweeps over the trochanter of the femur, being separated from that bone by a multilocular bursa. After receiving the insertion of the tensor vaginæ femoris, the fascia on the outer side of the thigh is attached to the outer tuberosity and surface of the tibia, and this is named the ilio-tibial band. The ilio-tibial band may be looked upon as the insertion of the tensor vaginæ femoris into the tibia. The external inter-muscular septum extends along the linea aspera from the insertion of the gluteus maximus to the outer condyle. It separates the vastus externus and crureus from the short head of the biceps. The internal septum separates the vastus internus from the adductor muscles. Hunter's canal is looked upon by some authors as a process of this fascia, stretching from the adductor longus and magnus to the vastus internus.

The saphenous opening is situate in the fascia lata a full inch in a horizontal line outside the spine of the pubes. The fascia outside this aperture is termed the iliac portion of the fascia lata, the fascia internal to it the pubic portion.

The fascia lata is perforated by the superficial external pubic and circumflex branches of the common femoral artery, and by the external, middle, and internal cutaneous nerves. The inter-muscular septa are perforated by numerous arterial branches of the profunda and superficial femoral. Behind the femoral vessels the fascia is connected with the capsule of the hip. That portion of the fascia which forms the outer curved margin of the saphenous opening is termed the falciform border, or femoral ligament, and is prolonged into Poupart's ligament and the spine of the pubes. The inner curved margin passes behind the outer, and curves upwards to the ilio-pectineal line, where it blends with the iliac fascia. The saphenous opening is closed by the cribriform fascia, and the saphen-

ous vein with its radicles, and no true opening here exists in the healthy living body. At this weak spot a femoral hernia appears, when it is complete.[1]

Practical Points.—Abscess beneath this fascia may burrow extensively. Thus a psoas abscess will readily work downwards as far as the knee, and conversely an abscess in connection with necrosis of the lower end of the articular part of the femur may burrow towards Scarpa's triangle. In traumatic aneurisms the effused blood is limited by this fascia; hence the general hard swelling of the limb in these cases, the agonising pain, the tendency to gangrene of the limb below. The fascia lata is a favourite structure for sarcomatous growths to originate in. In cases of "contracted hip" after disease, or in old cases of paraplegia, the fascia lata becomes much contracted, and free division of bands of it with a tenotome is often needful.

Ligaments of Knee-joint.—In an amputation through the joint, the flaps are raised, and the knife passes through the articulation from before backwards. The ligamentum patellæ would first be divided, the capsular and lateral ligaments, the synovial folds, the anterior crucial ligament, the posterior crucial ligament, and the posterior ligament of the knee-joint. Immediately behind the posterior ligament is the popliteal artery, which, especially remark, is only separated from the joint by this ligament. Aneurisms occasionally, therefore, implicate the joint, and the artery may be wounded by an incautious operator in excising the articulation. The vein is intimately adherent to the artery, and, as the knife passed out behind, it would divide the internal popliteal nerve and hamstring tendons. Looking at the articular aspect of the tibia, you will see the semi-lunar cartilages—the external one circular, the internal not completely so. Note that they are attached by the coronary ligaments to the bone, but may readily slide forwards or backwards. Sometimes they become fractured or

[1] The anatomy of these parts is again considered in treating of femoral hernia.

displaced by violence, and are sutured into position after opening the articulation; loose portions of them may be entirely removed. The main function of the crucial ligaments is to hold the bones together. The anterior one by passing to the outer condyle checks rotation of the leg inwards, effected by the popliteus; the posterior passing to the inner condyle checks rotation of the leg outwards, effected by the biceps. When these ligaments are destroyed by disease, pathological displacement results. The movements permitted in the knee are flexion and extension, and rotation, especially in the flexed position.

Synovial Membrane of Knee.—There is only one synovial membrane in the knee-joint, and the superior tibio-fibular articulation is lined by a separate synovial sac, which, however, sometimes communicates with the knee. To mark out the limits of the synovial membrane of the knee, first observe it distended in a case of synovitis, and then you will see exactly where to draw your boundary line. Start at the back of the articulation, by drawing two lines across the popliteal space, opposite the articular margins of the femur and tibia. On arriving at the inner side of the joint, the lower of these lines will be continued anteriorly just below the articular edge of the tibia to the ligamentum patellæ, where the margins of the membrane descend to form a distinct pouch beneath the ligament. Continuing the line along the outer articular edge of the tibia to the popliteal space, it will mark the lower limit of the membrane. Next take the upper of the two lines at the inner side of the joint, and continue it upwards and anteriorly, drawing a large pouch beneath the vastus internus, which reaches to full three inches above the articulation; this line crosses the rectus about two inches above the patella, when the leg is extended. Continuing outwards, you draw a pouch beneath the vastus externus, on a lower level than that on the inner side, and continue your line to the popliteal region again.

Practical Points.—In operations on the lower end of the

femur, as the removal of an exostosis, the synovial membrane is likely to be wounded, unless you well flex the leg upon the thigh; this draws the sac somewhat downwards. The pouch beneath the ligamentum patellæ may be readily wounded by an incautious operator in this region. Stabs and punctured wounds in the lower part of the thigh are exceedingly likely to open the knee-joint, and this serious complication may be quite unexpected. The swelling, when the synovial membrane is excessively distended, takes place on either side of the extensor tendon above and ligamentum patellæ below. In these situations the capsular ligament is defective. There is usually also an aperture in the capsular ligament behind the joint on the inner side, and through this the bursa beneath the semi-membranosus tendon communicates with the joint. Two prominent folds of the synovial membrane of the knee pass from the pad of fat between the patella and the tibia to the sides of the intercondyloid space. A third fold passes from the centre of the "pad" to the inter-condylar notch. In cases of "pulpy disease" these folds are much enlarged, and may explain that bulging which is seen in front of the knee in these cases, which so closely simulates dislocation of the tibia backwards.

Bursæ.—The bursæ about the knee are numerous and important. There are four on the front and inner aspect of the knee, and five posteriorly. The anterior bursal sacs are as follows:—Firstly, the deep bursa of the femur. This lies between the front of the femur and the rectus femoris, full three inches above the patella. This sac is in intimate relation with the synovial membrane, and I suspect that the synovitis of the knee, which usually accompanies fracture of the shaft of the femur, is due to the inflammation of this bursa being propagated to the synovial membrane of the knee. When suppuration occurs in the knee-joint, a deep abscess may readily burrow upwards beneath the rectus by this route, and open near the apex of Scarpa's triangle. The well-known bursa patella is situated over the lower part of the front of

the patella and ligamentum patellæ. It lies between a prolongation of the fascia lata and the bone. Another small bursa may exist between the skin and this fascial prolongation. The surgical importanee of the patella bursa is great. When it suppurates, a red fluetuating swelling obscures the patella and front of the knee, and this is too often mistaken for fluid in the joint. Fortunately, the attachments of the deep fascia to the sides of the bone usually prevent the products of suppuration from entering the artieulation. When this bursa is solid from chronie inflammation, it has sometimes to be dissected out. Keep the knife towards the bursa when operating, and be very eautious in removing that part of it whieh overlies the ligamentum patellæ, lest you wound the synovial membrane. A bursa has been already mentioned between the ligamentum patellæ and the upper part of the tuberele of the tibia. The last of the four bursæ about the knee is little known by students. It is situated on the inner side of the joint, between the tendons of the graeilis and semi-tendinosus and the internal lateral ligament of the knee. A prolongation of it passes between the sartorius and those tendons at their insertion. Turning now to the back of the joint, we find three bursæ on the inner side of the popliteal space, and two on the outer. The first of the three saes on the inner side is situated beneath the inner head of the gastrocnemius and the back of the inner condyle, the second between the semi-membranosus and gastrocnemius,[1] and the third between the semi-membranosus and back of the tibia. The first and second often eommunicate with the joint. On the outer side of the popliteal space you find a bursa beneath the outer head of the gastroenemius, and another beneath the tendon of the popliteus, which is usually a direet extension of the synovial membrane of the knee. Lastly, a bursa may be found between the biceps and the external lateral ligament. You will find these structures differently

[1] This is considered by some to be a mere prolongation of the bursa beneath the gastroenemius.

described by different authors, the fact being that they are difficult to certainly demonstrate, and adventitious bursæ are often found over prominent bony points. One can never be certain that a bursal swelling does not communicate with the joint, and for surgical purposes always suspect a possible communication. An enlarged bursa is the commonest swelling of the popliteal space, and may form a cyst of great size in this region or in the ham.

Arteries and Veins.—To delineate the course of the femoral artery, flex and abduct the thigh and leg. Draw a line along the front and inner aspect, from midway between the anterior-superior spine and the symphysis pubis, to a point at the junction of the lower with the middle third of the thigh opposite the inner condyle of the femur. The first two inches of this line correspond to the common femoral artery, the remainder to the superficial femoral artery, and you must not confound the one with the other. The deep femoral is given off about two inches below the ligament of Poupart. The femoral vein lies to the inner side of the artery above, but in Hunter's canal crosses behind it, and gets to the outer side below. The sartorius crosses the vessel in its middle third. It is further covered by the fascia lata, and certain branches of the anterior crural nerve. The relations of the vessel in Hunter's canal and the triangle of Scarpa will be hereafter considered. If the artery be tied at the apex of Scarpa's triangle, the common situation for operation, the circulation would be carried on to the parts below the ligature by the following anastomosis. The descending branches of the external and internal circumflex, anastomose with the articular of the popliteal, the anastomotica magna, and muscular twigs of the femoral. The perforating twigs of the profunda femoris anastomose with muscular twigs all down the back of the thigh, and the sciatic branch of the internal iliac brings the blood directly down to the popliteal region, anastomosing with muscular and perforating branches. Having considered these points, and if possible studied the

different operations on the femoral artery, compress it against the pubes. Standing a little behind the hip of your recumbent subject, let the fingers rest on the anterior spine of the ilium, and your thumb on the vessel immediately under Poupart's ligament. Direct the pressure backwards and upwards, so as to compress the vessel against the pubes—not against the femur. Practise this until you can do it certainly and instantly; very slight effort is sufficient when the direction of pressure is right. No practical surgical examiner will tolerate uncertainty or ignorance in such matters as these.

To mark out the course of the popliteal artery, turn the subject on his face, and draw a line from above downwards, and within outwards, from the inner and highest aspect of the popliteal space, to about an inch below the level of the knee-joint. This point is opposite the lower border of the popliteus posteriorly, and the tubercle of the tibia anteriorly. Mark out the vein superficial to the artery, by drawing a line close to the outer side of the artery for the greater part of its extent, but crossing it to the inner side at the lower third. The internal popliteal nerve has the same relation to the artery as the vein, but is still more superficial.

It is often needful to cut down upon the shaft of the femur for acute affections of the periosteum, or necrosis, or to explore a doubtful tumour. Mark the position of such an incision on the outer side of the thigh, splitting the parallel fibres of the ilio-tibial band longitudinally.

Nerves.—The cutaneous nerves of the thigh are as follows: —The external cutaneous nerve pierces the fascia lata as two branches about three inches below Poupart's ligament, and supplies the integument posteriorly and anteriorly. The crural branch of the genito-crural nerve pierces the fascia just to the outer side of the common femoral artery. The middle cutaneous nerve pierces the fascia lata about four inches below Poupart's ligament. Of the internal cutaneous nerve, one twig pierces the fascia at the saphenous opening, another about three inches below Poupart's ligament to the inner side of the

artery, and a third about the middle of the thigh to the inner side of the saphenous vein. The anterior branch pierces the fascia just below the knee. The long saphenous nerve becomes cutaneous at the inner side of the knee, between the tendons of the gracilis and semi-tendinosus. The nervous plexus about the patella is formed by twigs of the long saphenous, internal cutaneous, middle cutaneous, and sometimes the obturator nerves. At the back of the thigh the skin of the outer aspect is supplied by descending filaments of the external cutaneous nerve, the skin of the inner aspect by twigs of the internal cutaneous nerve. The small sciatic nerve becomes cutaneous below the popliteal space, and supplies the skin of the back of the calf. Twigs of it supply the skin of the back of the thigh also. Severe "neuralgic" pains are experienced in the course of these nerves in such serious and obscure affections as abdominal aneurisms, cancer or calculus of the kidney, and deeply-seated caries and tumours of the bones of the pelvis and spine. The trunk of the anterior crural nerve lies external to the femoral artery, between the iliacus and psoas. It takes origin from the third and fourth lumbar nerves mainly, so that its origin from the cord would be about opposite the last dorsal vertebra. The obturator nerve emerges at the upper part of the obturator foramen, and divides into a superficial and deep leash of branches. The superficial branches collectively supply the articulation of the hip, the adductor longus and brevis, the gracilis and pectineus muscles. The deep branches supply the adductor magnus and obturator externus. The articular twig for the knee lies upon the great adductor, and perforates it in the lower third to enter the popliteal space. It enters the knee through the posterior ligament. The obturator nerve has much the same spinal origin as the anterior crural, and the same practical considerations apply to pains in its course. The knee-joint is supplied by nervous twigs from the anterior crural, obturator, external and internal popliteal nerves. The muscles supplied by these nerves about the knee are consequently often in a

state of irritation and spasm in acute disease of this joint. The distribution of the obturator nerve to both hip and knee explains the common phenomenon of pain in the knee when the hip-joint is diseased. This is due to an error in the impressions of the patient, who refers the pain to the terminal distribution of the nerve.

Mark out the course of the great sciatic nerve by drawing a line down the back of the thigh in the median line. Commence this above, in the upper part of the "hollow" between the tuberosity of the ischium and great trochanter, and half-an-inch nearer the ischium than the trochanter, and terminate just below the middle of the thigh. This great nerve lies in succession upon the gemelli, obturator internus, quadratus femoris, and adductor magnus muscles, and is covered by the gluteus maximus and biceps. If this nerve had been divided by a stab in the upper part of the thigh, you would find the hamstring muscles and all the muscles of the leg and foot wasted and paralysed. The muscles on the front of the thigh would not be affected. Sensation would be lost over the cutaneous areas of distribution of the anterior tibial, musculo-cutaneous, and external saphenous nerves, but would be maintained down the back of the "calf" of the leg, and down the inner side of the leg and foot as far as the ball of the great toe, these parts being supplied by the small sciatic and long saphenous nerves respectively. If the nerve were divided low down, the "hamstring" muscles would be unaffected. In such cases the patient can walk by swinging forward the wasted leg flail-like. The extensors and flexors of the leg upon the thigh perform their functions naturally.

Lymphatic Glands.—There may be said to be five groups of lymphatic glands in the lower limb. These are as follows:—Four or five small glands surround the popliteal artery, and receive the deep lymphatics of the back of the leg, and also some superficial trunks from the skin of the heel and outer side of the dorsum of the foot. Hence they may become inflamed, and a deep abscess may form, from poisoned wounds

of these parts. Sometimes a small gland is found on the front of the interosseous membrane with the anterior tibial artery. The femoral or lower inguinal glands are arranged in two groups, superficial and deep. The superficial set are arranged vertically, and receive most of the lymph from the skin of the lower extremity. They are often inflamed, and may sometimes suppurate in poisoned wounds of the integuments. The deep glands surround the femoral artery, and one is found in the crural canal or in the crural ring. When one of these glands is inflamed, the similarity to a femoral hernia is often very close. Finally, we turn to the buttock, and find two groups surrounding the sciatic and gluteal arteries. When any of the above groups of glands become secondarily affected with malignant disease, large, irregular, hard, nodular, fixed, and painful tumours may become apparent. The original source of infection may be slight. Thus it is not uncommon for a patient to show us a large tumour in the groin of this nature, following the extirpation of a small "melanotic" wart on the dorsum of the foot, or an epithelial cancer of the lower part of the rectum and anus. The majority of the femoral glands lie above the fascia lata, and can usually be removed without implicating the femoral vessels.

Hunter's Canal. — Flex and abduct the thigh, and draw an oblique line three and a half inches long, from just below the apex of Scarpa's triangle to the adductor opening at the junction of the middle and lower thirds of the thigh. This will correspond to Hunter's canal. If you made an incision along the chalk line, you would first avoid the saphenous vein between the superficial and deep fascia. After dividing the deep fascia, you would find the fibres of the sartorius sweeping downwards and inwards. Drawing the sartorius inwards, you would observe the fibres of the vastus internus passing downwards and outwards. You would now come upon the canal itself, formed by a dense aponeurosis derived from the vastus internus, and stretching from that muscle on

the outer side to the adductor longus and magnus on the inner. The canal is triangular, the apex of the triangle being directed towards the linea aspera of the femur. Should you still further investigate the canal, you would find that it contains the femoral artery and vein, and the long saphenous nerve, with the anastomotica magna branch of the femoral artery. The femoral vein passes behind the artery, and lies here to its outer side, the long saphenous nerve is outside the sheath of the vessels and in front of them. It pierces the roof of Hunter's canal in its lower third, and becomes cutaneous, as has been already described, below the knee. The superficial twig of the anastomotica magna artery also pierces Hunter's canal, so that the only structures of surgical importance which pass through the adductor opening are the femoral artery and vein, the vein lying behind and to the outer side of the artery. The adductor opening is situated at the junction of the lower and middle thirds of the thigh close to the femur.

Popliteal Space.—Turn your subject on his face, and mark out the diamond-shaped popliteal space. The outer limit is the biceps tendon above, the outer head of the gastrocnemius below. The inner boundary is formed by the semi-membranosus and semi-tendinosus above, the inner head of the gastrocnemius below. The popliteal artery traverses this space from above downwards, lying upon the back of the femur, posterior ligament of the knee-joint, and popliteus muscle. The vein, intimately adherent to it, lies to the outer side, but crosses it to the inner side in its lower third. The internal popliteal nerve lies superficial and external to the artery above, and crosses to its inner side below. The external popliteal nerve can be defined passing from within outwards close to the biceps tendon, beneath which it passes to wind round the head of the fibula. The lymphatic glands surround the vessels, and deep in the space, on the inner side and above, can be seen the tendon of the adductor magnus fixed to the tubercle above the inner condyle of the femur. The tendon

of the popliteus arises from the back part of the outer condyle, and where the plantaris exists; it can be seen arising above the outer head of the gastrocnemius. Necrosis of the femur on its popliteal aspect is a common and troublesome affection, and abscess originates in connection with it. The anatomy of the popliteal space suggests the surgical affections of this region. Thus, in connection with the vessels, we meet with aneurism and arterio-venous aneurism. The vessel lying upon the bone may also be unfortunately wounded in a bad fracture of the lower end of the femur. In connection with the bursæ, already dealt with in detail, are cysts and semi-solid swellings: the popliteal glands may be the seat of abscess, or solid tumours, and such are prone to pulsate and simulate aneurism closely, because the artery heaves them up and down. Lastly, the cancellous tissue of the ends of the bones is a favourite seat of growth of sarcomatous tumours.

CHAPTER XII.

REGION OF GROIN AND BUTTOCK. THE HIP-JOINT.

Bony Landmarks.—Define the anterior-superior spine of the ilium and the spine of the pubes. The latter point of bone is best detected by abducting the thigh, when the tense tendon of the adductor longus will lead up to it. The anterior-superior spine of the ilium is of great importance. In cases of shortening of one lower extremity, you measure carefully from it to the inner malleolus. If the measurement be exactly the same on both sides, the shortening is apparent, not real. Before measuring, be careful that the limbs are both precisely in the same position; they should be extended, the patient lying perfectly flat on a hard couch. If the shortening be apparent, one iliac spine will be tilted to a correspondingly higher level than the other, as can well be demonstrated by joining them with the tape. True shortening is found in fractures of the femur or bones of the leg, in dorsal dislocations of the hip due to accident or congenital peculiarities, in the later stages of hip disease, and very rarely in early hip disease, when the inflammation is so acute that the capsule yields and allows the head of the bone to become displaced. True shortening is also found in cases of paralysis, where the bones are stunted in growth. Apparent lengthening, sometimes apparent shortening, are found in early hip disease. You must note that one lower extremity may be longer than the other. This may be due to congenital peculiarity, and

is markedly found when one femur is affected with chronic osteitis.[1]

The anterior-superior spine is of importance in determining the condition of mobility of the hip in suspected disease. Place your finger upon it, and fully flex and extend the thigh on the pelvis; the spine of the ilium does not move, but if there be mischief in the joint it tilts forwards as you extend or flex the femur, thus fixing the hip-joint. Take the first opportunity of observing this on a boy suffering from early hip disease. The anterior-superior spine tilts forwards in extension of a diseased hip, by a curvature of the lumbar spine forwards. Thus, if you place a patient suffering from hip disease, or anchylosis of the hip, on a flat couch, and try to bring his flexed thigh straight, you will notice that the lumbar spine will bend forwards, so that a hollow is left under the back, in which you may place your closed fist. Now flex the thigh, and you will find that the spine becomes flat again. This curvature of the lumbar spine forwards is termed "lordosis," and is observed in all fixed conditions of the hip-joint to a greater or less degree. Finally draw a line from the anterior-superior spine to the tuberosity of the ilium. This is the familiar Nélaton's line, and it just touches the top of the trochanter major. Keeping the tape in position, abduct the thigh to its fullest extent, and you find that the trochanter rises a little above this line, so that the statement that the trochanter is below the line of Nélaton in all positions of the hip is not strictly accurate. In conditions which cause shortening where the head and neck of the femur are fractured, diseased, or displaced, the trochanter must rise above this important line. As familiar instances we may quote chronic arthritis of the hip, with absorption of the head of the bone, fracture of the neck of the femur,

[1] True and apparent shortening may be associated. In measuring the lower extremities, beware of ascertaining slight differences, as a quarter of an inch, by the aid of the tape. Such slight measurements are exceedingly fallacious.

and late hip disease, where the head of the bone is destroyed by necrosis, and the neck displaced above the acetabulum, or drawn into it. In dorsal dislocations the trochanter is markedly above the line of Nélaton. In a case of real shortening, therefore, the line of Nélaton enables you at once to say whether the mischief be in the upper end of the femur or not. Next draw a horizontal line directly backwards from the anterior-superior spine, and join this with Nélaton's line as it skirts the trochanter. Thus Bryant's ilio-femoral triangle is formed. The vertical base line is of course shortened in all conditions in which the trochanter is above its proper level.

The spine of the pubes is appealed to in the diagnosis between femoral and inguinal ruptures lying internal to a femoral, external to an inguinal hernia. In large old inguinal hernia, this rule does not certainly apply. If you dissect such cases, you will find the large neck of the sac lying upon Poupart's ligament outside the spine.

Trochanter.—The great trochanter of the femur is separated from the skin by the fascial insertion of the gluteus maximus and a large multilocular bursa. Place the subject on his side, and consider the position of the muscular insertions. A vertical line, two inches long, drawn from the middle of the posterior margin of the trochanter above, would correspond to the insertion of the quadratus femoris. A diagonal line drawn from the posterior-superior to the anterior-inferior angle, delineates the attachment of the gluteus medius. A short line drawn along the anterior border marks the gluteus minimus. On the upper margin of the trochanter mark the obturator internus in front, the pyriformis muscle behind.

Scarpa's Triangle.—The base is formed by Poupart's ligament, and extends from the anterior-superior spine of the ilium to the spine of the pubes. Note that Poupart's ligament is convex towards the thigh, from the tension of the fascia lata which is attached to it. The outer boundary corresponds to the sartorius, the inner to the margin of the

adductor longus. Now draw the femoral artery from midway between the spine of the ilium and symphysis pubis, to the apex of the triangle, mark the vein to its inner side, and put in the saphenous vein dipping through the saphenous opening to join it. Now, let us suppose that the integument is removed over the space marked. The superficial layer of the superficial fascia is exposed, and this is continuous with the fascia of the abdomen and perineum, and the dartos of the scrotum. Remove the superficial layer, and the deep areolar layer of superficial fascia is exposed. This blends with Poupart's ligament above, and at the margins of the saphenous opening is adherent to the fascia lata, covering in the oval opening with a thin and delicate fascia traversed by fibrous septa. This is perforated by the saphenous vein and its radicles, the superficial epigastric artery, lymphaties, and a twig of the middle cutaneous nerve. Hence it is termed the cribriform fascia. Clear away the deep layer of superficial fascia, and you expose the fascia lata. This has already been described.[1] Note especially the exact position of the saphenous opening, and the attachments of its upper and outer, and lower and inner, cornua. Remove the fascia lata. The parts in the floor of the triangle will here be fully exposed, and also the femoral sheath. This we must carefully consider. The transversalis fascia of the abdomen comes down under Poupart's ligament in front of the vessels, and blends with the iliac portion of the fascia lata. The iliac fascia, which covers the psoas and iliacus, descends posteriorly, and blends at the back of the vessels with the pubic portion of the fascia lata. These structures are continuous on the outer side of the artery and the inner side of the vein. A septum exists between the vein and artery, and another thin septum separates the vein from the inner wall of the sheath. Thus a narrow passage exists between the femoral vein covered by a septum and the inner wall of the sheath; this is funnel-shaped, and extends from the crural ring behind Poupart's

[1] Chap. xi.

ligament above to the level of the saphenous opening below. In the article on hernia this canal will be again alluded to.

The parts exposed in the floor of Scarpa's triangle from without inwards would be as follows:—The external cutaneous nerve, the iliacus muscle, the anterior crural nerve, the psoas muscle and its sheath, the femoral vessels and genito-crural nerve, the pectineus and adductor brevis. All these structures are found in the anterior flap, in a "transfixion" amputation at the hip-joint.

The psoas muscle is separated from the capsule of the hip-joint by a large bursa, which may form a cystic swelling of great size in connection with arthritis of the hip, and may also simulate abscess when inflamed. In "hip disease," abscess frequently finds its way into this bursa. When the head of the femur is out of the acetabulum, the psoas and pectineus muscles sink backwards, and the femoral vessels, instead of pulsating prominently, recede into a hollow and are difficult to demonstrate. This is one of the most important signs of dislocations of the hip. The hip-joint can be opened for purposes of erasion and drainage, or excision of carious bone, by an incision placed between the sartorius and tensor vaginæ femoris, starting just below the anterior-superior spine. This exposes the iliacus, and the finger displacing this muscle inwards comes at once upon the capsule and neck of the femur. In early hip disease the distension of the capsule is most apparent in front, and this distension, aided by inflammatory swelling of the soft parts, leads to obliteration of the fold of the groin and increased heat; both of these symptoms are of the first importance, for they cannot be simulated. The sheath of the psoas muscle, formed by the dense iliac fascia, passes into Scarpa's triangle to the outer side of the femoral vessels, and then passes behind them.

Psoas Abscess.—A spinal or other abscess descending along the psoas muscle is long confined by the fascia, but at length, bursting through it, the abscess suddenly appears as a fluctuating swelling to the inner side of the femoral vessels.

This has an impulse on coughing, and is reducible, so that the similarity to hernia is very great, and an error is often committed. The hip is flexed by the patient to relax the psoas muscle, and the gluteus maximus muscle is wasted.[1] When the abscess has opened a discharging sinus remains; this may be far down the thigh, and thus you are apt to think that necrosis of the femur exists, or disease of the hip is present. The hip-joint has been excised, or even amputation of the entire limb performed, in cases of spinal disease. Both errors are terrible and grave. Lastly, note that an obturator hernia will push forwards the pectineus muscle, and cause a fulness in Scarpa's triangle, with pain down the thigh to the knee in the course of the obturator nerve. Turn the subject on his face, and place a pillow under the pelvis, so as to examine the region of the buttock.

Bony Landmarks.—Define the highest point of the crest of the ilium, and run the finger backwards and downwards to the posterior-superior spine of the ilium. The posterior-superior spine is nearly opposite the spine of the first piece of the sacrum. Draw a line from the posterior-superior spine to the tuberosity of the ischium. In this line the posterior-inferior spine is situated one inch and a-half below the posterior-superior spine, and the spine of the ischium three and a half to four inches. The sciatic vessels and nerves issue from the pelvis just below the spine of the ischium, at the junction of the lower and middle thirds of the above line. Draw a curved line from the posterior-superior spine to the end of the sacrum, along the side of the latter bone; this will roughly correspond with the attachment of the great sacro-sciatic ligament to this part of the pelvis. The lower extremity of the ligament is attached to the inner edge of the tuberosity of the ischium. The tuberosity of the ischium is plainly to be felt, and the origin of the hamstring tendons arising from it. Next feel the spines of the sacrum. The arch of the first sacral

[1] I cannot agree with those authorities who affirm that the wasted buttock in these cases is not due to muscular atrophy.

vertebra is often deficient, and "spina bifida" is commonly found in this situation. The spinal cord in the adult does not extend further than the upper border of the second lumbar vertebra, but the "filum terminale" extends through the sacrum, and issues below to blend with the periosteum over the coccyx. The central canal of the cord descends to the level of the third sacral spine.

Roughly speaking, the gluteal vessels and nerves issue from the pelvis opposite a point at the junction of the inner and middle thirds, of a line drawn from the posterior-superior spine to the great trochanter rotated inwards.

Muscles.—The outline of the gluteus maximus is fairly distinct, and it can be readily marked in chalk. The origin of this muscle extends in a bold sweep from the side of the coccyx, along the sacrum, and the superior curved line of the ilium to the crest, about three inches beyond the posterior-superior spine. This muscle wastes very early in disease of the hip. Its main function, extension of the femur, is early interfered with, by the patient always keeping the thigh a little flexed. It is supplied by the inferior gluteal nerve. The gluteus medius and minimus can be marked out by drawing fan-shaped figures, the bases of which correspond to the middle and inferior curved lines of the ilium, the apices to the insertions of these muscles into the trochanter major. The position of the pyriformis is indicated by drawing a pyramidal figure, the base of which corresponds to a line drawn along the side and back of the sacrum opposite the second and fourth sacral spines, the tendinous apex to the front, and upper border of the great trochanter. This muscle divides the sciatic notch into two parts, the gluteal vessels and nerve issuing above it, the sciatic and pudic vessels and nerves below it.

Nerves.—The position of the sciatic and gluteal nerves has been indicated. The cutaneous nerves of the buttock are as follows:—The posterior twigs of the external cutaneous nerve are found behind the great trochanter; next in order are the lateral cutaneous branch of the last dorsal nerve and

the iliac branch of the ilio-hypogastric. The external twigs of the posterior divisions of the first three sacral nerves pierce the fascia along the side of the sacrum at regular intervals. Finally, the pudendal twig of the small sciatic nerve sends ascending filaments over the gluteal fold.

Bursæ.—The buttock is a favourite seat of enlarged bursæ; these may be semi-solid, or inflamed, or form cystic swellings, varying in size from a small orange to a man's head. Always have the possibility of a bursal affection in your mind when investigating swellings in this region. Some of the more important bursæ about the buttock are as follows:—A multilocular bursa separates the great trochanter from the tendon of the gluteus maximus, and another bursa intervenes between the gluteus maximus and the vastus externus. Two bursæ, deeply placed, lie between the tendon of the obturator internus and the ischium and capsule of the hip-joint. Over the tuberosity of the ischium is placed a large bursa, often enlarged in weavers and coachmen. Between the trochanter and the tendons of gluteus medius and gluteus minimus small bursæ are interposed.

Hip-Joint.—This most important articulation is formed by the head of the femur rotating in the cup-shaped acetabulum. The acetabulum is deep and strong above, but is thin and incomplete below. The head of the femur could hardly be displaced upwards without fracturing the rim of the acetabulum. The head of the femur joins the neck at about the eighteenth year; before that time acute inflammation, followed by necrosis, may attack the epiphysial line, and cause separation of the head of the bone. The three pieces of the acetabulum unite about the sixteenth year. Before that time acute abscess of the joint may destroy the cartilaginous lines of juncture, and burrow through the acetabulum into the pelvis.

The movements of the hip are flexion, extension, rotation outwards and inwards, abduction, adduction and circumduction. Flexion is mainly performed by the psoas and iliacus; this movement is only complete when the leg is flexed to relax the

hamstring muscles, and is checked by the contact of the soft parts of the thigh and abdomen. Extension is performed mainly by the gluteus maximus, and is checked by the tension of the anterior part of the capsule of the joint. In order to keep the capsule relaxed, slight flexion is always maintained in early hip disease. The gluteus medius and minimus are the principal abductors of the thigh. Their action is checked by the front and lower part of the capsule. The action of the adductors is checked by the ligamentum teres and upper part of the capsule. Rotation outwards is performed by the gluteus maximus, the posterior fibres of the gluteus medius, the pyriformis and gemelli, and the obturators with the quadratus femoris. These muscles are termed the external rotators of the thigh, and to their uncontrolled action is attributed that eversion of the lower limb observed in fractures of the neck of the femur. The weight of the limb, and its natural tendency to roll outwards when the neck of the femur is broken, are more probable explanations. The thigh is rotated inwards by the anterior fibres of the gluteus medius and the gluteus minimus.

Muscular relations of the Hip.—In front are the psoas and iliacus muscles and a large bursa. Behind, the pyriformis, gemelli, obturators, and quadratus femoris. Above is the straight tendon of the rectus femoris and the gluteus minimus. Internally are the obturator externus and pectineus.

The capsular ligament of the hip is a most important surgical structure. Remember its attachment to the femur. Above, to the neck, close to the head; below and in front, to the anterior inter-trochanteric line; behind, to the middle of the neck. Thus, in one part, its attachment is close to the head of the femur, in others to the trochanter. It follows that most fractures of the neck of the femur are both within and without the capsule of the hip. The capsular ligament is attached to the margins of the acetabulum and anterior-inferior iliac spine, below, it is incomplete opposite the notch in the cotyloid ligament. A great deal has been written about the cap-

sular ligament of the hip, and various names have been given to bands and portions of it isolated by the genius of dissectors. Surgical anatomists will lay stress on the following points of importance. The strongest part of the capsule is anteriorly. Here the longitudinal fibres can be defined as a broad triangle, the base of which is attached to the anterior inter-trochanteric line, the apex to the anterior-inferior spine of the ilium, and adjacent part of the acetabulum. The outer and inner sides of this triangle are thicker than its centre, and being connected into one bundle at the spine of the ilium, the whole structure has received the name of the Y ligament of Bigelow. This is of great strength, and to its resistance is attributed the inversion of the hip, which occurs in backward dislocations. It also forms a kind of fulcrum, upon which the swinging movements of reduction of those dislocations is performed. In dislocations, the head of the bone almost invariably leaves the socket where the capsule is weakest and the acetabulum shallowest, namely, at the lower part near the transverse notch. In abduction, the head of the femur bulges here, and it has been pointed out by Morris that the ligamentum teres is slack in abduction, and any sudden violence may tear it from its attachments, so that there is a natural tendency to dislocation of the hip in the position of abduction. The synovial membrane of the joint is extensive, and too often the seat of tubercular disease. It lines that portion of the neck of the femur within the capsule, the inner surface of the capsule itself, and also surrounds the ligamentum teres. Comparatively often it communicates anteriorly with the bursa beneath the psoas tendon. At the bottom of the acetabulum it covers a pad of fat, the so-called Haversian gland.

Before taking leave of the hip-joint, let us attempt to explain the positions the parts assume in diseases and injuries.

The nerves that supply the hip are twigs from the sacral plexus, obturator, accessory obturator, and great sciatic. These nerves supply the majority of the muscles which act upon the joint. When the joint is inflamed and diseased, groups of

museles are thrown into spasmodic aetion, and the positions of the limb in disease of the hip are, to a eertain extent, thus explained. In the very early stages of "hip disease," apparent lengthening is usually observed. This is said to be due to abduetor spasm. If you stand up, and abduct the thigh well from the pelvis, you will find that by dropping the pelvis on the same side, you can maintain equilibrium and produee at the same time apparent lengthening. Later on adductor spasm supervenes, and then apparent shortening takes place. Adduet one limb behind the other; by raising the pelvis on that side, you will find that the limbs are brought parallel, and equilibrium is maintained, while apparent shortening is produced. Flexion, adduetion, inversion, and apparent shortening are the common positions of the lower limb in later hip disease, and this position has been said to allow of the greatest distension of the joint by fluid, and therefore of the greatest ease to the patient. Doubtless this last consideration is an important factor. Real shortening will supervene sooner or later, the troehanter being raised above Nélaton's line. Some authorities have maintained that exeessive effusion into the joint will produee this position, and it has been stated that even true elongation of the limb may thus be produeed. Regarding this it may be remarked, that inflammatory effusion eould never be poured into a joint with sueh pressure as experimenters have used, and, considering the strength of the ligaments, a natural doubt may arise whether true elongation eould possibly be brought about without destruetion of them. When the head of the femur is disintegrated, or destruetion of the capsule allows the earious head of the bone to beeome displaced upwards, true shortening oeeurs, as shown by measuring from the anterior-superior spine to the malleolus, and the troehanter rises above Nélaton's line. In early hip disease this is almost unknown, unless in most aeute cases, as after the "specifie" fevers. Such is a brief summary of the leading ideas as to the position of the lower limb in hip disease, but the question is a most difficult one to deal with eertainly and

lucidly; and the varied accounts of these phenomena only illustrate the uncertainty which still exists in the minds of various authorities.

It is here impossible to enter into a detailed consideration of the symptoms of dislocations and fractures about the hip. The following points are of paramount importance. The lower limb is markedly everted in fracture of the neck of the femur, and more slightly in the obturator and pubic dislocations. The limb is inverted in dislocations on the dorsum ilii, and into the sciatic notch, and in certain exceptional impacted fractures of the neck of the femur. When the head of the femur is displaced, the femoral vessels sink back into a hollow in the groin, and the head of the bone can usually be felt in the buttock under deep manipulation with anæsthetics. The trochanter is raised above the line of Nélaton in fractures of the neck of the femur and the backward dislocations; in the obturator dislocation the trochanter sinks into a deep hollow, and the limb is abducted and really lengthened,[1] the adductor longus standing out like a rounded cord, excessively stretched and tense.

Place the limb into the position of the four common dislocations of the hip, and practise the manipulations for reduction of each of them. Also place the limb in the position it assumes when fracture of the neck of the femur has taken place.

[1] Some authorities maintain that the lengthening is apparent, and due to twisting of the pelvis.

CHAPTER XIII.

INGUINAL AND FEMORAL HERNIA.

Inguinal Hernia.—Mark the external abdominal ring in chalk. It is a triangular opening in the external oblique aponeurosis, about one inch and a quarter in length. The base corresponds to the crest of the pubes between the spine and the angle. The external pillar is Poupart's ligament attached to the spine of the pubes; the internal pillar, formed by the external oblique, arches in front of the external, to be attached to the angle and symphysis pubis. The external pillar of the ring, constituted by Poupart's ligament, sends fibres directly backwards and outwards along the ilio-pectineal line for about an inch. They terminate by a free concave margin turned towards the femoral ring. This reflection of Poupart's ligament is termed Gimbernat's ligament. Some of the fibres of the external pillar of the ring and Gimbernat's ligament arch beneath the cord, and blend with the front of the sheath of the rectus behind the internal pillar; they form the triangular fascia, which is therefore behind the ring. The external ring, when distended, might split up the oblique muscle, were it not braced together by a series of looped fibres, the convexity of each loop looking towards the pubes. A fascia derived from the deep layer of the superficial fascia of the abdomen assists in closing the aperture. These structures are termed the intercolumnar fascia and fibres. The spermatic cord in the male, and round ligament in the female, pass through the external abdominal ring, and the cord lies upon Poupart's ligament just outside the spine of the pubes, the testes being, so to

speak, "slung" upon Poupart's ligament. The ilio-inguinal nerve also pierces the intercolumnar fascia.

Mark out the internal abdominal ring as an oval opening, with its long diameter nearly vertical, half-an-inch above Poupart's ligament, and midway between the anterior-superior spine and symphysis pubis. It is an orifice made by the passage of the round ligament, or the spermatic cord, in the transversalis fascia. Its margins, especially the external one, are well marked and fibrous, and if you could look at the ring from the inside, you would see a delicate fascia prolonged from its margins along the cord. This is the infundibuliform fascia which closes in the ring. An oblique inguinal hernia is usually strangulated at the deep ring either by the arched fibres of the transversalis fascia or the thickened neck of the sac. Before leaving the ring, draw the deep epigastric artery along its inner side from the middle of Poupart's ligament towards the umbilicus. Thus it will be clear that an ordinary oblique hernia has this important vessel to its inner side.

Next mark out the inguinal canal. It extends obliquely downwards and inwards from the internal to the external ring. Its length is very variable, but take an inch and a half as a fair average. If you have an opportunity in the post-mortem room, cut down upon the external ring, and thrust your finger right up the inguinal canal. In the living subject you can introduce your finger some little way by invaginating the scrotum. Pressing the finger downwards, you feel Poupart's ligament, and the union with it of the fascia transversalis; pressing it upwards, the finger impinges against the arched fibres of the internal oblique and transversalis; pressing it backwards towards the belly, you plainly recognise the broad tendinous attachment of the conjoined internal oblique and transversalis, to the crest and ilio-pectineal line of the pubes. In front of this is Gimbernat's ligament, and the triangular fascia or ligament before described. Behind the conjoined tendon is the attachment of the transversalis fascia to the linea ilio pectinea. The finger pressed forwards feels the

external oblique for the whole length of the canal, and the internal oblique for the outer third. If you put a bistoury into the canal, and cut it open anteriorly from end to end, you will find these two muscles divided. It is especially important that you should feel the more prominent of these structures as well as read about them.

We have said that the external ring is covered by the intercolumnar fascia, the internal by the infundibuliform fascia. The lower fibres of the internal oblique, blended with a thin fascia, pass from the middle of Poupart's ligament in a series of loops over the cord, and ascend in its inner side, to be inserted into the front of the sheath of the rectus. This is the cremaster muscle and fascia, supplied by the genital branch of the genito-crural nerve. Next, suppose a hernia enters the inguinal canal, and traverses its whole length, passing into the scrotum; the spermatic cord will lie behind the sac, and the testis below and behind; the inguinal canal will be distended right up to the abdomen, and the cord obscured by the gut, but the testis is plainly to be felt. These are important distinctions between hernia and hydrocele of the tunica vaginalis.

As the gut descends it pushes before it a layer of peritoneum and areolar fatty tissue. Next worming its way through the internal ring, it gets a covering from the infundibuliform fascia. Proceeding along the canal it approaches the cremasteric fascia, and gets covered by it, and finally, appearing through the external ring, acquires its most external coverings, the intercolumnar fascia, superficial fascia, and integument. The intercolumnar fascia is termed by some the external spermatic fascia, and the infundibuliform fascia the internal spermatic fascia. Thus, to enumerate the coverings of a complete oblique inguinal hernia, you only have to think of the various structures which form the abdominal wall, and remember that the hernia must get a covering from each of them.

Hesselbach's Triangle.—This space can be marked out by drawing a line from Poupart's ligament to the edge of the

rectus abdominis in the direction of the umbilicus. This line starts from a point just to the inner side of the external iliac artery, and corresponds with the course of the deep epigastric artery. It forms the outer margin of the triangle. A line drawn along the outer edge of the rectus corresponds with the inner margin. The base is marked by a line drawn along Poupart's ligament from the edge of the rectus, joining the extremities of the two preceding. Looking at the inner surface of this triangle, the obliterated hypogastric artery is seen traversing it from below upwards. This vessel throws the peritoneum in the floor of the triangle into two grooves: one external, between the obliterated hypogastric artery and the deep epigastric artery; another internal, between the obliterated hypogastric artery and the rectus.

Sometimes a hernia, instead of getting into the canal by the internal ring, will pass through Hesselbach's triangle, and force the conjoined tendon before it, passing internal to the obliterated hypogastric artery. The transversalis fascia will cover it (not its infundibuliform portion), and, instead of the cremasteric fascia, it will have before it the expanded conjoined tendon. This is called a direct inguinal hernia, and is acquired, not congenital. The epigastric artery manifestly lies well outside the neck of the sac. The seat of stricture in direct hernia is usually at the neck of the sac or the external ring. In dividing the stricture in either variety of hernia, cut upwards, so as to be parellel with the epigastric vessel. It is not always possible to distinguish between an oblique and direct inguinal hernia. In well-marked cases and thin subjects, this may be done by attending to the following manipulations:—Flex and invert the thigh, and reduce the rupture. Make firm pressure with your fingers over the internal ring, and instruct the patient to cough strongly. If the rupture protrudes inside your fingers, you may conclude that it is a direct hernia; if your fingers keep it back, you may conclude that it would come out of the abdomen through the internal ring, and is "oblique." It has been well pointed out by

Lockwood, that the spermatic cord does not accompany a direct hernia in its whole course, but can be felt approaching it from the outer side, and this observation I have several times been able to verify.

A congenital inguinal hernia need not exist at birth. By this term you mean a hernia that owes its existence to some congenital defect. This "defect" is usually an abnormal patency of the funicular process of peritoneum which accompanies the cord. In these cases, the peritoneal cavity and the sac of the tunica vaginalis are in direct continuity. The communication may be large and direct, or small and tight. In either case fluid may collect in the tunica vaginalis, forming a congenital hydrocele. This affection is common in young children, and as the fluid can be reduced into the belly, the resemblance to hernia is very close. Should a hernia come through the patent funicular process, it may descend below the testicle, the latter being behind and in surgical contact with the gut; anatomically, it is separated from the intestine by the thin testicular layer of the tunica vaginalis. It is said that, in congenital hernia, the testis and gut are in the same sac, but strictly speaking this is not true. This form of hernia often comes down suddenly, and furnishes examples of dangerous and deadly forms of acute strangulation in young adults. In these cases delay in operating is highly reprehensible. In most cases of congenital hernia it is difficult to recognise the testicle, and this may serve as a diagnostic hint that the testis and gut are in the same sac, surgically speaking.

Infantile Hernia.—This is an acquired hernia due to congenital defect. The funicular process is closed by a septum, and a secondary pouch descends from this situation behind the funicular process. A coil of gut descends into this pouch, and gradually distends it. In cutting down upon such a hernia you would divide three serous layers. The first and second would be the anterior and posterior layers of the funicular process, the third the anterior layer of the secondary

pouch posterior to it (Infantile Hernia of Hey). Though termed "infantile," this hernia may not be developed until adult life. Therefore the term is not a good one.

It has been assumed that when the patent funicular process is merely closed by a septum, that a coil of gut may push this septum before it, distending it gradually into a sac, and descending into the cavity of the tunica vaginalis. In cutting down upon the gut, therefore, you would divide firstly the tunica vaginalis, and then the sac formed by the distended septum (Encysted Hernia of Cooper). Much doubt has lately been thrown upon the existence of this form of rupture.[1]

Mark out the incision for inguinal hernia by a line one and a half inches long, from the middle of the canal to the lower part of the external ring. The superficial epigastric artery will be divided. In operating upon inguinal hernia, the principal structure to recognise is the sac, and this is said to be a transparent membrane, rough on the outside, smooth and shining on its interior, with arborescent vessels on the surface. I may definitely tell you that all these guides are highly fallacious; and if you closely observe an operator, you will often see that he is not quite sure of the sac, until a jet of fluid tells him he has opened it. When you expect a structure is the sac, open it with great care, the knife being held flat, as though you were opening the sheath of an artery. The escape of fluid is good evidence that the sac has been opened, and the coil of gut, dark and congested, will usually show itself. But all hernial sacs do not contain fluid, and the tissues may be matted by inflammation. If the gut is exposed, your finger nail or a director will pass right into the abdominal cavity past its neck, which will not be the case if you are dealing with one of the coverings of the gut. In a congenital hernia, deal carefully with any structures found at the back of the sac, as these are the constituents of the cord separated and spread out. In operations for "radical" cure

[1] See *Lockwood on Hernia.*

of hernia where the sac is twisted and excised, the vas deferens is, especially in children, too often unintentionally injured. Herniæ containing the cæcum or bladder may have no peritoneal covering.[1] In operations upon such, you are exceedingly likely to wound these structures. In cases of old inflamed hernia, when the tissues are matted, the gut may easily be wounded. Hardly two cases of hernia are similar, and no fixed rule can be laid down for the performance of the operation.

Femoral Hernia.—Read carefully what has been said regarding the anatomy of femoral hernia in the article on Scarpa's triangle. Mark out the saphenous opening as an oval aperture with a vertical long diameter of an inch, one inch and a half in a horizontal line outside the spine of the pubes, and half-an-inch below Poupart's ligament. Mark out the femoral or crural ring, immediately behind Poupart's ligament (the subject being recumbent) to the inner side of the external iliac vein. The crural ring may be said to lie behind Poupart's ligament about half-an-inch internal to the external iliac artery. Next mark out the crural canal. This extends from the crural ring above to the saphenous opening below, and is about three-quarters of an inch long. If, therefore, you chalk a line half-an-inch long, from Poupart's ligament above to the saphenous opening below, on the inner side of the femoral vein, you indicate the course of the crural canal, and, what is as important, you mark the incision that one would make in cutting down on a femoral hernia. The superficial external pudic artery may be divided, and requires ligature in the incision. Now to more particularly describe, at the risk of recapitulation, the anatomical parts you have just delineated. The saphenous opening is formed in the fascia lata of the thigh. To its margin is attached the cribriform fascia, derived from the deep layer of the superficial

[1] The cæcum is usually covered by peritoneum, but when it descends into a hernia, the peritoneum may be in great part "stripped" off it, but this is not generally the case.

fascia of the thigh. This is perforated by the saphenous vein or its radieles, lymphaties, the superficial epigastric artery, and a braneh of the anterior erural nerve. The outer erural superior border of the saphenous opening lies in front of the femoral sheath, blending with it. The front of the femoral sheath is formed by the transversalis faseia of the abdomen; therefore the front of the femoral sheath or transversalis faseia blends with the iliae portion of the faseia lata and outer border of the saphenous opening. This faleiform outer border of the saphenous opening is very distinet, and is prolonged upwards and inwards to Poupart's ligament and the spine of the pubes to the inner side of the femoral sheath. The lower and inner border of the saphenous opening eurves behind the femoral vein to blend with the posterior wall of the femoral sheath, formed by the iliae faseia.

The erural or femoral ring is said to be larger in the female than the male, and femoral rupture is more eommon in women aeeordingly. The best way to understand and reeolleet the boundaries of the femoral ring, is to go into the disseeting room and view it from the inside of the abdomen. Pass the finger beneath Poupart's ligament to the inner side of the external iliae vein, and it will lie in the erural ring. You will see that the spaee whieh here exists is oval, with its long diameter transverse, and is elosed in life by a septum (septum crurale) and some areolar tissue. Keep your finger in the opening. To the outer side will lie the femoral vein, separated by a thin septum from your finger; inside you plainly feel the fibrous margins of Gimbernat's ligament, the conjoined tendon of the internal oblique and transversalis, and the deep erural areh. Above is the deep erural areh, the erural areh, the deep epigastrie artery, and the spermatie cord in the male. These struetures would be divided if you put a bistoury into the ring and eut direetly upwards and forwards. Below, your finger rests on the pubes and iliae faseia. The deep erural or femoral areh is a thiekened band of fibres derived from the transversalis faseia, arehing over

the femoral vessels and crural ring, from the pectineal line behind the conjoined tendon internally to Poupart's ligament externally. The crural arch is Poupart's ligament. The seat of stricture in a femoral rupture is at the femoral ring, and the safest place to notch it, is internally through Gimbernat's ligament. The obturator artery should come off from the internal iliac. Sometimes it arises from the deep epigastric, and passes downwards to the obturator foramen to the outer or inner side of the femoral ring. If it passes to the outer side it is out of harm's way, if to the inner it may be divided, and a serious hæmorrhage take place. I may add that this is rare, and need not embarrass your mind when operating.

The crural canal is about half-an-inch long, and does not exist as a space in the healthy body, being filled by connective tissue, and often containing a lymphatic gland. It extends from the crural ring above to the saphenous opening below. Externally is the femoral vein covered by a septum, internally the junction of the anterior with the posterior layer of the femoral sheath, anteriorly the front wall of the femoral sheath formed by transversalis fascia, posteriorly the back wall of the femoral sheath formed by iliac fascia.

Suppose now that a coil of intestine, covered by its peritoneal sac, pushes its way through the femoral ring, it will be covered by a layer of areolar tissue loaded with fat, and the septum crurale. Next it distends the crural canal, and bulges out at the saphenous opening, having as fresh coverings the anterior wall of the sheath and the cribriform fascia; it then mounts up to Poupart's ligament, and has its long diameter directed transversely to the thigh. On cutting down from the surface, the operator would divide integument, superficial and cribriform fascia, anterior femoral sheath, septum crurale, sub-peritoneal areolar tissue, and lastly the peritoneal sac. The sub-peritoneal tissue overlying the peritoneum is often so full of fat that, when you expose it, you think you have opened the sac and are dealing with omentum.

Always cautiously divide a fatty layer in femoral hernia, and you will probably find the sac beneath it. Divide the stricture inwards, notching the edge of Gimbernat's ligament. The septum crurale and anterior wall of the femoral sheath are surgically indistinguishable, and form a layer called by the old authors the "fascia propria" of a femoral hernia.

It is sometimes difficult to distinguish between an inguinal and femoral hernia. The neck of an inguinal hernia lies internal to the spine of the pubes and above Poupart's ligament. A femoral hernia is external to the spine of the pubes and below Poupart's ligament, and its long axis is transverse and not oblique.

CHAPTER XIV.

THE EAR.

The Auricle.—The auricle or pinna is composed of yellow fibro-cartilage bent and convoluted in various forms; it is not essential to hearing. The largest concavity surrounding the meatus is termed the concha, the hollow just above it the triangular fossa, and the long curved valley lying most externally between the helix and anti-helix is termed the fossa of the anti-helix. The prominent ridge of the helix starts from the upper part of the concha and sweeps right round the pinna; becoming indistinct below, it forms the incurved margin of the pinna. The ridge just in front of it is the anti-helix. The little projection in front of the meatus is the tragus, and that behind it the anti-tragus; the part of the ear selected for earrings is termed the lobule. The integument is intimately adherent to the auricle, and contains sebaceous follicles; these, when inflamed, are intensely painful. The chief arteries of the pinna are the auricular twigs of the posterior-auricular branch of the external carotid, and the anterior-auricular from the superficial temporal. Those being very superficial, are readily constricted by cold, leading in extreme cases to gangrene or ulceration of the auricle.

Nerves.—Four sets of nervous filaments supply the skin of the auricle. The auriculo-temporal nerve supplies the tragus, the upper and anterior aspect of the pinna, and the skin of the meatus. The auricular branches of the great auricular nerve (from second and third cervical) supply the back of the pinna. Arnold's nerve supplies the lower and

back part of the pinna and the back part of the auditory canal. The small occipital sends a twig to the upper and inner aspect of the pinna. Numerous clinical examples could be adduced of the importance of a knowledge of these nerves. A carious tooth will often give rise to severe pain in the ear. Instances are related of coughing or sickness due to impacted wax. This is said to be reflex through the auricular branch of the vagus. Again, a boil at the auditory meatus will excite severe neuralgic pains about the jaw and side of the head.

The External Auditory Canal.—The auricle is prolonged inwards, like the stalk of a leaf, by the cartilaginous portion of the external auditory canal. The cartilaginous portion is a little less than half the length of the auditory canal, the whole length being one and a quarter inches. The cartilaginous canal is attached by rough fibrous tissue to the edge of the bony canal in the temporal bone. The tube of cartilage is not complete, being formed by fibrous tissue at the upper and back part; and its wall is traversed also by several incomplete clefts, the fissures of Santorini. The cartilaginous canal lies in contact with the parotid gland beneath; and a pyæmic abscess of the parotid has been known to burst into the canal above, and simulate otorrhœa from osseous disease. So, in caries of the osseus meatus, the pus may burrow in the parotid region and form sinuses, which from their anatomical position it is difficult to treat. The osseous canal is longer and narrower than the cartilaginous. Its lower wall is prolonged further inwards than its upper, and the membrana tympani is set obliquely to the long axis of the canal. The external auditory canal is not straight, being inclined forwards, at first ascending and then dipping over an eminence situated in the floor of the osseous part near its commencement. The integument is prolonged right into it, forming the lining membrane, and the outer layer of the membrana tympani. Hair and glandular structures are not found in the bony canal, but in the cartilaginous canal they are abundant. The arteries of the canal are the auricular twigs of the temporal,

posterior-auricular, and internal maxillary. The nerves are from the auriculo-temporal and Arnold's nerve.

The posterior wall of the osseous canal corresponds to the mastoid cells, the anterior wall to the temporo-maxillary joint, the roof to the posterior fossa of the skull, the floor to the base of the styloid process of the temporal bone. Caries and necrosis of the bony canal may thus implicate the cranial cavity or the joint of the jaw. Dermoid cysts have been found in the auditory canal, and such are extremely apt to lie deeply, having absorbed the bone. They have been even known to implicate the brain.

Membrana Tympani and Ossicula Auditus.—The tympanic membrane is set obliquely sloping downwards and inwards. Its outer layer is dermic, its inner derived from the lining of the tympanum; between the two is fibrous tissue, both radiating and circumferential. The stylo-mastoid branch of the posterior-auricular artery, and the tympanic branch of the internal maxillary, supply the membrane with blood. The handle of the malleus descends between the mucous and fibrous layers to the centre, bowing the membrane somewhat inwards. Immediately above the handle of the malleus the membrane is incomplete, the notch between it and the upper wall being filled by a loose tissue sometimes perforated. This gap is termed the notch of Rivini; the loose tissue, the membrana flaccida, or Shrapnell's membrane. The malleus articulates with the incus, and the incus with the stapes, which is fixed in the fenestra ovalis. The membrane covering the fenestra ovalis closes the opening to the vestibule. The base of the stapes is covered by cartilage, and there is also a layer of the same substance upon the membrane, fibrous tissue uniting the two cartilaginous surfaces. When the stapes and its attachments are intact, the power of hearing is seldom quite lost even in cases of advanced perforative otorrhœa. It is in these cases that an artificial drum gives such surprising results, when gently placed upon the ossicle. Paracentesis of the membrane should usually be performed through its lower part,

to avoid the chorda tympani nerve. In cases of fracture of the middle fossa of the base of the skull, the tympanic membrane is often rent, so that the fracture becomes really a compound one.

Mastoid.—The mastoid process stands prominently out behind the auricle, and is only completely developed at the age of puberty. In children, the bony shell covering it is easily perforated, being thin and diaphanous. In adults, it may be, especially in cases of chronic disease, thick, dense, and hard. The mastoid cells are exceedingly variable in number, size, and form. Having examined a large number of sections of the mastoid, I am unable to perceive any absolutely typical arrangement. There are usually four major spaces, the largest would contain an ordinary pea; they communicate with the posterior aspect of the tympanic cavity by one large and several small openings, situated on the upper part of the posterior wall. The largest of these spaces, termed the mastoid antrum, lies much further internally than is usually supposed, being contained in the base of the petrous bone. The lining membrane is continuous with that of the tympanum, and often inflammatory changes are propagated from one cavity to the other. The cells are separated from the cranial cavity and great lateral sinus, by a thin lamella of bone, often perforated. The line of the lateral sinus is from the occipital protuberance to the front border of the mastoid. This great venous channel is very variable in its outward curvature. In some skulls it is deeply seated, and separated from the cells by a distinct bony lamina, in others it approaches so near the surface as to render it in great danger of being wounded in operations on the mastoid.

In opening the mastoid for abscess or necrosis, work inwards and forwards parallel with a probe placed in the auditory canal. Remove the external table with a small mallet and gouge, just behind the meatus, and with the same instruments gently proceed, until you are able to break into the cavities freely with a blunt director. The skin incision may be made

vertical to avoid the posterior auricular vessel, but it is better in all ways to turn a large flap from the mastoid to expose its entire surface. Owing to the close connection between the mastoid and lateral sinus, and the fact that veins pass from the mastoid cells to the latter channel, purulent phlebitis and pyæmia are often consequences of necrosis and caries of the mastoid. The mastoid emissary vein is usually inflamed and thrombosed in cases of thrombosis of the lateral sinus. This vein perforates the bone about one inch behind the auditory meatus, and its condition, as pointed out by Barker, affords a useful clue to the state of the lateral sinus. In fracture of the posterior fossa of the skull, extravasation of blood about the mastoid is a most important symptom.

Tympanum.—There is perhaps nothing more important in the whole range of anatomy, than a consideration of the structures that lie about the tympanic cavity. Consider this space as a small, irregular, four-sided bony cavity, with the membrana tympani externally and the bony labyrinth internally. It is seldom more than a sixth of an inch across, and contains the chain of ossicles with their minute ligaments and muscles, and the chorda tympani nerve. The thin roof corresponds to the anterior and upper surface of the petrous portion of the temporal bone, and the temporo-sphenoidal lobe of the brain. The floor is in relation with the jugular fossa and vein behind, the carotid canal and internal carotid artery in front. The roof descends so that the anterior boundary of the cavity is an angle, from which the bony part of the Eustachian tube passes. Just above the tube is the canal for the tensor tympani muscle. The posterior wall corresponds with the mastoid, and shows the several openings to the cellular spaces in that bone. The outer wall corresponds with the tympanic membrane, the inner corresponds with the labyrinth, and among other objects of importance, you perceive upon it the fenestra ovalis above covering the vestibule, the fenestra rotunda below covering the "scala tympani" of the cochlea. Between these openings is the "promontory" caused by the outward bulge of the first

turn of the cochlea, and a ridge indicating the important aqueduct of Fallopius, containing the facial nerve.

The Eustachian tube is about an inch and a half long, and composed of an osseous and cartilaginous portion. It opens by a lipped aperture into the pharynx, above the soft palate and behind the inferior turbinate bone. When chronic inflammatory processes occur in the tympanum, organisation of tissue leads to impairment of movements of the bones, anchylosis of the stapes in the fenestra ovalis, thickening of the membrana tympani, and many other changes of an irremediable character. Caries and necrosis of the walls of the tympanum is obviously a condition fraught with great risk, owing to the anatomical relations above related. Thus cerebral abscess and meningitis are too common, the abscess being usually found in the temporo-sphenoidal lobe of the brain overlying the thin roof of the tympanum. Purulent phlebitis of the jugular vein with pyæmia is not uncommon, and even fatal bleeding has occurred, from erosion of the carotid or one of its twigs. When caries attacks the inner wall, the aqueduct of Fallopius is involved, and facial paralysis of a permanent kind may be the distressing result. Caries and necrosis of the mastoid often occur in these cases, and mastoid abscess may result, or the cellular spaces be stuffed with caseating products of inflammation.

CHAPTER XV.

THE EYE.

On looking at the eye, you perceive the lids and eyelashes, with the cornea and selerotie covered by conjunctiva. On the margins of the lids, near the inner canthus, are the small puncta lachrymalia. The reddish body at the inner canthus is termed the caruncula lachrymalis, and the fold of conjunctiva here found, the plica semilunaris. This is the representative of the membrana nictitans of some birds. The carunele contains connective tissues, and is covered by a few fine hairs. Sarcomatous growths may originate in the conjunctiva. When it is destroyed by accidental burning with lime, etc., the opposed surfaces of the eyeball and lids may unite. This is termed symblepharon. The conjunctiva swells excessively in certain inflammatory affections, especially purulent ophthalmia. The cornea has its nutrition interfered with on account of the inflammatory stasis in the conjunctival vessels, and sloughing or ulceration of it is the principal complication to be feared. The conjunctival vessels are usually visible, especially when the membrane is inflamed. Slight pressure upon the globe suffices to empty them, and on removing the finger a temporary spot of pearly whiteness is perceived, which almost instantly becomes again suffused with blood. Continuing your inspection, you note the iris and the margin of the pupil. To discover whether the pupil acts properly to light, make the patient cover one eye with his hand, and place him before a bright light or window. Now stand behind the patient and interpose your hand like a diaphragm, between the eye under

examination and the light. Attentively watch the pupil at the same time and it will dilate, quickly withdraw your hand and it will contract. I mention this a little in detail, for it is a most important diagnostic proceeding in cases of iritis, and is often imperfectly carried out.

Eyelids.—Injuries of the eyelids are not uncommon, and such affections as tarsal cysts, nævi, and rodent ulcer are frequently met with upon them. It is an essential matter to unite any wounds of the lids with the greatest accuracy and care. Congenital gaps may be seen in the eyelids, and be associated with similar gaps in the iris, and even in the choroid (coloboma). If you cut through the lids from without, you divide the skin, orbicularis, and levator palpebræ muscle fibres, the plates of fibrous tissue known as the tarsal cartilages, the Meibomian glands, and the conjunctiva. The glands are very numerous, and arranged in parallel rows under the ocular conjunctiva, their ducts opening by minute apertures at the margin of the lids. Obstruction of the ducts of these glands leads to the formation of the common "tarsal cyst," which is therefore below the cartilage. The muscle which opens the eye by raising the upper lid, is the levator palpebræ, supplied by the third nerve. The muscle which closes the eye, is the orbicularis palpebrarum supplied by the facial nerve. The integument of the upper lid is supplied by the lachrymal, supra-orbital, and supra-trochlear twigs of the ophthalmic division of the fifth nerve; the integument of the lower lid, by the palpebral branches of the superior maxillary nerve. The arteries of the lids are the lachrymal and palpebral twigs of the ophthalmic. The conjunctiva is supplied externally by the lachrymal nerve, internally by the infra-trochlear, above by the supra-trochlear, below by the palpebral twigs of the superior maxillary.

Lachrymal Apparatus.—Trace a tear throughout its entire course, supposing it passes into the nose and not on to the cheeks. The lachrymal gland, about the size of an almond, is situated in a depression in the upper and outer wall of the

orbit, lying in a hollow of the frontal bone above and to the outer side of the external rectus. Its ducts have been estimated as about twenty in number, and open at the margins of the upper lid, and at the outer canthus. The secretion of the gland issuing from these ducts flows across the eye to the puncta lachrymalia, along the canaliculi into the lachrymal sac, and down the lachrymal duct into the inferior meatus of the nose. The canaliculi are not straight but crooked, and hence if you wish to pass a probe along them through the puneta, you must draw the lids outwards. On drawing the lower lid well outwards, the tendo oculi can be felt. It crosses the lachrymal sac, about the centre, passing from the nasal process of the superior maxilla to the tarsal cartilages. The lachrymal sac is situate at the inner angle of the eye, and in cases of obstruction of the duct forms a manifest swelling, which can be emptied into the eye through the canaliculi by firm pressure; many sufferers from lachrymal obstruction constantly adopt this method of relieving themselves. Sometimes the sac suppurates, causing much redness and swelling of the face. The abscess should be evacuated by slitting up the canaliculus inferior, and not by opening it through the skin. The lachrymal sac is behind the tendo-palpebrarum, and the angular artery is close to its nasal side. The direction of the nasal duct is downwards, outwards, and backwards; its narrowest part is about the centre, and a valve-like fold of mucous membrane guards its lower orifice in the inferior meatus of the nose.

Iris.—The iris may be regarded as a circular muscular screen interposed between the anterior and posterior chambers, immediately in front of the lens. When the pupil is contracted, the iris rests upon the capsule of the lens; when it is dilated, the iris is removed from the lens, and the anterior and posterior chambers freely communicate. Hence the importance of dilating the pupil in iritis, so as to prevent it adhering to the anterior lens capsule. At its circumference, the iris is continuous with the choroid and the cornea by the "ligamentum pectinatum." The ligamentum pectinatum is the insertion of the

posterior elastic lamina of the cornea into the iris and front of the choroid and sclerotic, by festoon-like processes. Inflammation may thus extend from the cornea to the iris, and from the iris to the choroid. The nerves of the iris are derived from the sympathetic, third nerve, and nasal branch of the fifth, through the ciliary ganglion. The iris is composed of two sets of unstriped muscle fibres, circular and radiating. The sphincter fibres are supplied by the third nerve, the radiating by the sympathetic. When the third nerve is paralysed the pupil consequently dilates, when the sympathetic is paralysed, as by the pressure of a tumour in the neck, the pupil contracts. The arteries of the iris are derived from the long ciliary, and form two arterial circles, a greater and a lesser, round the periphery and margin of the iris. In severe iritis they may be visible. Other important symptoms of iritis are a loss of the natural lustre of the pupil, sluggish movements of it, or evidence of actual adhesion to the lens, a tinted aqueous, and a salmon-coloured zone of pericorneal congestion.

Coats of Eyeball and its Contents.—If a pellet of shot were to strike a man in the centre of the cornea, and pass through the eyeball, it would penetrate the following structures:—The corneal conjunctiva, the corneal substance, the posterior lining membrane of the cornea (membrane of Descemet). It would then pass through the iris or pupil, and through the lens and its capsules, into the vitreous, and from thence pass out behind through the hyaloid membrane, retina, choroid, and sclerotic into the orbital tissue. Remember the following points concerning the coats of the eyeball. The cornea is not vascular, and readily sloughs or ulcerates from inflammation of its substance, or stasis in the conjunctival vessels round it. The cornea is abundantly supplied with nerves, which are the terminal twigs of the ciliary nerves from the ophthalmic ganglion. The thinnest part of the sclerotic is just behind the insertions of the muscles, and here rupture of the globe often occurs from violence. The ciliary region is immediately external to the cornea, and is a narrow zone,

about three millimètres in breadth, surrounding the globe. This corresponds internally with the termination of the choroid by a number of vascular plaited processes, the ciliary processes, which are situated radially behind the iris. The coats of the eyeball are here intimately connected, and many blood-vessels and nerves are distributed in this region. This is the dangerous region of the eye. Operators shun it; accidental wounds, especially if lacerated, of this part of the globe, are too often followed by "sympathetic" ophthalmia of the other eye, and consequent blindness.

The crystalline lens is kept in its place by the pressure of the aqueous humour in front and the vitreous behind. The suspensory ligament has been variously described, but you may understand it as passing to both anterior and posterior surfaces of the lens. Round the lens margin a space (canal of Petit) remains, through which the lymph freely percolates. Peripherally, the suspensory ligament is connected with the hyaloid membrane and ciliary muscle. When the muscle is at rest the lens is compressed by its capsule; when it contracts the capsule relaxes, and the lens becomes convex; and this is part of the act of accommodation. The exact action of the ciliary muscle in this respect is perhaps not yet certainly and clearly demonstrated. The eyeball is so fashioned that rays of light should be brought to a focus upon the retina: this is termed emmetropia. When the axis of the eyeball is too short for the refracting media within it, and rays are brought to a focus behind the retina, the term hypermetropia is applied. When the axis of the eyeball is too long, and rays of light are focussed in front of the retina, myopia or "short-sight" is produced.

Aqueous and Vitreous Humours.—The aqueous humour has a mere trace of saline matter in it, and no albumen. It is re-secreted as soon as removed. The vitreous humour is of jelly-like consistence, and quite transparent. It contains numerous small cells. Sometimes a delicate filament stretches across the pupil from the anterior surface of the iris. This is

the remains of the pupillary membrane of the fœtus, and, as it is attached to the anterior surface of the iris, it can always be distinguished from an iritic adhesion. A fine fibrous band may also persist in the vitreous humour, the obliterated hyaloid artery and vein of the fœtus.

Muscles and Movements of the Eyeball.—The movements of the globe are extremely complicated, yet the more important and marked of them are not difficult to understand. The external and internal recti move the globe, so that the cornea looks outwards and inwards respectively. These muscles are also associated in action in the two eyes. Thus, if we wish to look to the left, we use the left external and the right internal rectus; the superior rectus turns the eye upwards, the inferior downwards. The superior oblique, lying on the inner side of the orbit, its tendon passing through a pulley and then being inserted into the outer side of the globe, rotates the cornea downwards and outwards; the inferior oblique turns the cornea upwards and inwards. Suppose that two muscles, which are not opponents, act at the same time, their opposite actions counterbalance each other, and their similar actions, being combined, produce movement.

The nerve supply of these muscles is simple, the external rectus being supplied by the sixth cranial nerve, the superior oblique by the fourth, and all the others by filaments from the third. All the above muscles are divided in excision of the globe, and some of them are tenotomised in the various operations for strabismus.

Nerves of the Orbit and Eyeball.—Suppose the third nerve to be paralysed by the pressure of a gummatous tumour at the base of the brain, or by a clot of blood, the result of meningeal hæmorrhage. You will remember that the nerve supplies all the muscles of the eye but the superior oblique and external rectus. It also supplies the levator palpebræ, and through the ciliary ganglion the sphincter fibres of the iris. When this nerve is completely paralysed, the following symptoms are evident—dropped lid (ptosis), external stra-

bismus, and wide dilatation of the pupil (mydriasis). Sometimes the lid can be a little raised through the action of the fibres of the occipito-frontalis muscle inserted into it. Accommodation is defective for near objects, on account of paralysis of the ciliary muscle, which is, however, seldom complete.

If the sixth nerve be affected, the external rectus is paralysed, and there is internal squint; if the fourth, the superior oblique muscle suffers, but single paralysis of either of these muscles is not common. Double vision is the usual symptom of paralysis of the ocular muscles, and a rough test is employed by asking a patient to look at your finger about two feet distant from the front of his face. You then move it to and fro, and will often see which muscle lags behind the other, the patient at the same time declaring that he sees double. Cover both eyes in succession, and request the patient to closely watch an object about four feet distant. On uncovering one eye there should be no movement in the normal eye, but should there be a faulty muscle a correcting movement will have to be made, which will be apparent. These are "rough tests," as has been stated, and a good acquaintance with the use of prisms and coloured lenses is needful for the proper investigation of these cases.

In effusion of blood into the vitreous, glaucoma, or intra-ocular tumours, the ciliary nerves are pressed upon as they pass between the choroid and sclerotic. The pupil then becomes dilated, and the cornea anæsthetic. The two latter symptoms are of great importance in severe cases of glaucoma.

Paralysis of the ophthalmic division of the fifth nerve has already been dealt with in the article on the head. In this affection the cornea becomes anæsthetic, and often ulcerates and sloughs. Touching the cornea excites no reflex winking. The skin of the forehead and upper lid are anæsthetic, and those parts of the mucous membrane of the nose supplied by the nasal nerve. If the cornea on both sides is anæsthetic,

and no reflex obtained on touching it, in cases of general insensibility, the condition of the patient is critical. If such a condition is found in the cornea in cases of cerebral hæmorrhage, meningitis, abscess, and the like, death is not far off. In the administration of anæsthetics, when the pupil is dilated and reflex action abolished, the agent has probably been pushed to the limit of prudence.

Vessels.—The ophthalmic artery is one of the terminal branches of the internal carotid. It passes along the outer wall of the cavernous sinus. After fractures of the anterior fossa of the base of the skull, a communication sometimes takes place between the artery and sinus, and this leads to arterio-venous aneurism of the orbit. The artery enters the orbit through the optic foramen, and divides into two main sets of branches—those to the orbital tissues, ethmoidal, muscular, lachrymal, palpebral, frontal, and nasal; those to the eyeball itself, the anterior, long and short ciliary, and the central artery of the retina. The anterior ciliary arteries are derived from the muscular and lachrymal branches of the ophthalmic, and minute branches of them form a vascular ring round the margin of the cornea, beneath the conjunctiva. The vessels then pierce the sclerotic and join the external vascular circle of the iris. This pericorneal, subconjunctival, vascular zone, formed by twigs of the anterior ciliary vessels, is not visible in health, but in iritis, glaucoma, and especially inflammation of the ciliary body, the deep congestion causes these vessels to be engorged with blood, and the well-known "salmon-coloured" zone appears round the margin of the cornea. These little vessels are then not easily emptied by pressure with the finger, as is the case with the conjunctival arteries. If there is one important fact in the surgical anatomy of the eye, it is a consideration of the anterior ciliary arteries. A well-informed practitioner should look upon a ciliary zone of congestion in a case of "eye disease" as a symptom worthy of the closest attention.

The posterior group of ciliary arteries pierce the sclerotic

close to the optic nerve, and pass mostly to the choroid and ciliary processes, but two vessels (long ciliary) run forward between the choroid and sclerotic, and form the external vascular circle of the iris. When the central artery of the retina gets blocked by a clot carried upwards from a diseased heart, sudden blindness ensues, the retina being rendered completely anæmic.

Excision of the Eyeball.—In this operation, the conjunctiva and capsule of Tenon, a dense fascia which surrounds the sclerotic, are divided, with all the ocular muscles already mentioned, the ciliary arteries and nerves, the optic nerve and arteries centralis retinæ, muscular and conjunctival twigs of the ophthalmic artery, and the ophthalmic vein. Filaments of the first division of the fifth, the third, fourth, and sixth nerves are also divided.

Exploratory Incisions.—It is often needful to cut into the orbit to explore a swelling of doubtful nature, or remove a tumour springing from its walls. The incision may be made above the eyeball, or through the upper lid where it joins the roof of the orbit. The finger can be then readily inserted into the orbital cavity. The most room will be obtained on the outer side of the globe.

Fascia of the Orbit.—Allusion has been made to the capsule of Tenon, or subconjunctival fascia, which loosely surrounds the sclerotic. This structure gives fibrous investments to the tendons of the muscles, and sends processes to the walls of the orbit. It is firmly attached to the sclerotic behind, and in front blends with the conjunctiva and lids. In operations for strabismus and excision of the globe, it is most important that this structure should be divided, so that the operator works close to the sclerotic, and not outside the capsule of Tenon. The capsule of Tenon blends anteriorly with a series of looped fibres which pass across the orbit from the malar to the lachrymal bones, supporting the eyeball as a kind of sling (suspensory ligament of Lockwood). In removal of the upper jaw, it is most important that the attachments of this structure be

respected, for if it is roughly torn the eyeball sinks down in an unsightly manner.[1]

The Orbit.—The roof of the orbit is extremely thin, and may be readily pierced by any sharp or pointed instrument. The frontal lobe of the brain might thus be injured. The floor of the orbit is often bulged upwards by a tumour of the antrum; protrusion of one eye is a leading symptom in these cases. Tumours may also readily enter the orbit from the skull through the sphenoidal fissure, from the spheno-maxillary fossa by the spheno-maxillary fissure. A fracture of the inner orbital wall might open the ethmoidal cells, and a tumour growing there might readily infiltrate these cavities. So a meningocele may appear at the inner wall of the orbit, coming through the roof of the nasal fossa. A fracture running across the roof of the orbit is usually attended with hæmorrhage into the tissue behind the eyeball. It may also injure the cavernous sinus and artery, or the various oculo-motor nerves. The upper and outer angle of the orbit is a common situation for congenital "dermoid" cysts.

Glaucoma.—The anatomy of glaucomatous conditions of the globe is thus generally explained. In health there is supposed to be a free interchange of fluids between the vitreous and the anterior chamber. The fluids percolate through the hyaloid membrane and suspensory ligament of the lens to the posterior chamber, and this freely communicates with the anterior chamber. The fluid in the anterior chamber communicates with the ring of loose connective tissue in the sclerotic just anterior to the ciliary attachment of the iris. This is traversed by a circular lymphoid canal (canal of Schlemm) and a plexus of delicate veins, which finally drain away the fluids from the eye. In cases of glaucoma these lymphoid spaces are found blocked with inflammatory material; hence the increase of fluid and tension in the vitreous. As the tension of the vitreous increases, the nerves and vessels are pressed upon. The optic nerve being the most yielding

[1] Lockwood, *Journal of Anatomy and Physiology.*

part is pushed backwards, producing the "glaucomatous cup." The vessels towards the periphery of the retina first suffer, and the field of vision rapidly contracts in circumference. The lens is pushed forward nearly to touch the cornea, and the pericorneal sclerotic is of a deep salmon pink. In bad cases the pupil becomes sluggish and immoveable, and the cornea is anæsthetic. In speaking of the first division of the fifth nerve, attention has been drawn to the fact that in glaucoma the most agonising pain is experienced down the side of the nose, and over the head, so that the cases are often misunderstood. The rationale of iridectomy in glaucoma is as follows: part of a secreting structure is removed, and the incision allows of free escape of fluids from the anterior chamber.

Optic Neuritis—Choked Disc.—Swelling and hyperæmia of the termination of the optic nerve are found in a variety of conditions, for which a work on ophthalmic surgery must be consulted. The sheath of the optic nerve communicates with the sub-dural and sub-arachnoid spaces; all three membranes of the brain are prolonged upon it, the pia mater being intimately connected with the nerve. Thus in inflammatory conditions of the meninges, congestion of the optic nerve is always present to a greater or less degree. In cerebral tumour, or abscess, the congestion may spread along the nerve, and in such remote affections as thrombosis of the lateral sinus the consequent cerebral congestion often shows itself in the optic nerve.

Tumours of the Eyeball.—Tumours of the eyeball must not be confounded with tumours of the orbit. The common tumour of the eyeball is melanotic sarcoma of the choroid. This springs from the choroid, and pushes the retina in front of it. Detachment of the retina is an important early symptom of sarcoma of the choroid. Glioma is a malignant growth of the retina and optic nerve in infants and young children. It is usually a round-celled sarcoma, and is very prone to be mistaken by a careless observer for congenital cataract. As

these tumours increase, they press forward the lens, increase the tension of the eye, and render the pupil dilated and sluggish from pressure upon the ciliary nerves. Pain is now experienced in the globe, and "shooting" over the forehead and down the nose in the course of the branches of the first division of the fifth nerve.

CHAPTER XVI.

SPINE AND SPINAL CORD.

Bony Prominences.—The spines of the upper cervical vertebræ are only to be detected by deep pressure. The spines of the sixth and seventh cervical vertebræ project, and you must not mistake the marked prominence here found for the effect of disease. The spines of the dorsal vertebræ overlap each other, so that wounds of the cord from direct stabs are almost impossible in that region. A pointed instrument may wound the cord between the occiput and atlas, or the atlas and axis, and again in the upper lumbar region. The spines of the dorsal vertebræ being oblique, do not correspond to the bodies of the vertebræ. Each spine is opposite the body of the vertebra below. The lumbar spines project horizontally backwards, and correspond with the bodies of the vertebræ. The vertebral spines from the seventh cervical to the third sacral are practically subcutaneous, and may be readily broken off by violence. Slight deviations from the middle line, or prominences of one or more spines, may be met with in practice without any disease being present.

Curves.—In the fœtus there are two marked spinal curves, the dorsal and sacral. In infancy and early childhood the dorsal curve is very pronounced, leading to the condition termed kyphosis in the weakly or rickety infant. The cervical and lumbar curves are gradually developed after birth. They are principally dependent upon the shape of the inter-vertebral discs. In adult life, a slight lateral curve, with its convexity towards the right, is not uncommon in the upper dorsal region.

This is probably due to the use of the right arm for laborious occupations. The movements of the spine are principally flexion and extension. Rotation and lateral movements are permitted in the cervical region, and in the lumbar region. Flexion is most free in the dorso-lumbar region.

Fractures and Dislocations, Sprains.—Dislocation without fracture is hardly possible, except between the upper cervical vertebræ. A dislocation in the lower cervical or dorsal region is usually combined with fracture, and the cord is completely smashed at the seat of injury. The bones often spring back to their original position when the violence is removed, so that the resulting paralysis is due to crush of the cord, not to pressure upon it. Trephining the spine, when there is evidence of complete cord severance, is not followed by any encouraging results. The common situations for fractured spine are in the dorso-lumbar region, the cervico-dorsal region, or at the upper cervical region. The connection of ruptured kidney with fracture of the dorsal spine low down is well known.

The effects of fracture of the spine will vary according to the situation of the injury and the amount of damage inflicted upon the cord. If the cord be completely crushed, complete loss of motion and sensation is observed below the seat of injury. The phrenic nerve comes mainly from the fourth cervical, receiving branches from the third and fifth cervical. Fracture of the spine, with crush of the cord, above the fourth cervical vertebra, is followed by instant death, as is well exemplified in the modern "long-drop" system of judicial hanging. In fracture of the lower cervical region the patient may live for some days, breathing by his diaphragm alone; he commonly dies from pulmonary congestion and respiratory difficulties. The intercostal muscles are paralysed, but sensation is maintained over the shoulders, upper arm, and front of the chest, through the descending twigs of the cervical plexus. Fractures and injuries of the spine in the cervical region may implicate the origin of the spinal-accessory nerve, which extends as low as the sixth vertebra. Severe gastric dis-

turbances have been noted in these cases from the implication of the vagus, through its intimate connections with the spinal-accessory. Fractures in the dorso-lumbar region are generally associated with complete paraplegia. The lower down the fracture, the less complete the symptoms. In the lumbar region the canal is very large, and the bundle of nerves termed the cauda equina may quite escape injury, or be only partly implicated. Fractures low down in the lumbar region are rare. In such a case I have known the nerves to escape entirely at first. In a few months paraplegia supervened from pressure of reparative material. This gradually disappeared, and the man completely recovered. It must be remembered that the spinal nerves for the most part pass obliquely from the cord, so that their origin is higher than their exit. Thus a fracture of the eleventh dorsal vertebra might injure the origins of the last dorsal and first lumbar nerves, and might lacerate the trunks of the eleventh lumbar nerves. The irritation of the nerves by fragments of broken bone gives rise to a zone of intense hyperæsthesia (girdle pains) at the upper level of the paralysed parts.

Sprains of the spine are associated with stretching, sometimes rupture, of the deep muscles and fascia of the back, the ligaments of the spine, and synovitis of the joints between the rib and the transverse processes. In such cases hæmorrhages may occur in the spinal canal, between the membranes, or into the cord itself.

Cord and Membranes.—The spinal cord is about eighteen inches in length, and extends from the margin of the foramen magnum to the lower border of the first lumbar vertebra. In the fœtus it occupies the whole length of the canal. At birth the cord extends to the third lumbar vertebra. The dura mater of the cord is separated from the bones by areolar tissue and venous plexuses of large size. These receive deep veins from the back, and may be the source of serious hæmorrhage in spinal injuries. The sub-dural and sub-arachnoid spaces are filled with cerebro-spinal fluid. The cord, invested

by its pia mater, is suspended in the sub-arachnoid space by processes of fibrous tissue (ligamentum denticulatum), and the roots of the spinal nerves.

The cord ends as the filium terminale. This is a process of pia mater containing grey matter, and the central canal of the cord. It pierces the dura mater about opposite the second sacral vertebra, and escapes from the canal becoming blended with the fibrous tissue over the coccyx. The central canal and grey matter extend to about half its length. In caries and necrosis of the sacrum the result of bed-sore, fatal inflammation may spread up the cord along the filium terminale.

The sub-arachnoid space of the cord communicates with the central sub-arachnoid cavity, and this with the central ventricles. The sub-arachnoid space is also continued along the main nerves to some distance from the cord. Thus, in cerebral meningitis, the inflammation readily passes down the spinal membranes, and *vice versa*. In post-mortem examinations on those dead of purulent spinal meningitis, layers of pus may be traced along the main nerves to some distance from the spine.

Effects of Fracture of the Spine on the Genito-urinary Organs and Rectum.—The micturition centre is situated in the lumbar region of the cord. When a fracture with cord lesion occurs above it, all influences, ascending and descending, to or from the brain are cut off. Hence arises retention of urine, with its usual accompanying symptom, incontinence. When the bladder becomes distended, it usually contracts and expels the urine without the patient being aware of the fact. The contraction is seldom sufficient to completely empty the bladder, some urine usually remaining. If the damage implicate the micturition centre itself, or the nerves coming from it, the bladder may be completely paralysed, and chronic incontinence of urine ensue. In these cases the urine rapidly becomes decomposed, ammoniacal, and offensive. This is due not only to retention in the bladder, but also to the admixture, with the urine, of quantities of

alkaline mucus from the walls of an engorged bladder. This mucus is said to contain certain ferments in solution, which rapidly decompose the urea. Keeping the bladder constantly empty by careful catheterisation, and washing it out with antiseptic solutions, are among the first principles of treatment in fractured spine.

Priapism is a common and important symptom of fracture of the spine in the upper dorsal or cervical region. Singularly enough, it is commonly absent in fracture of the lower dorsal or upper lumbar spine. The explanation of the occurrence of this symptom is as follows. The erection centre is probably of considerable extent, and situated in the cord opposite the lumbar and lower dorsal regions. It is under the command of stimulating and inhibitory influences from the brain. When these are cut off, any peripheral stimulation of the penis causes an uncontrolled erection, of which the patient is quite unconscious. When the injury is near the erection centre, this is destroyed either directly or by the results of secondary inflammation, and consequently the penis remains flaccid. The condition of the rectum in fracture of the spine falls under much the same considerations as that of the bladder.

Spina bifida.—The neural arches of the upper sacral and lower lumbar vertebræ may be absent through congenital defect. A hernial protrusion of the membranes of the cord through the opening thus formed, constitutes a "spina bifida." Its coverings are skin, dura mater, and arachnoid, but these are so blended by adhesion and pressure that a mere translucent membrane alone is to be demonstrated. The nerves of the cauda equina often pass to the centre of the tumour, this condition being marked by a little dimple on the surface. In rarer cases the accumulation of fluid is in the centre of the spinal canal, the nervous substance and pia mater will then form a thin covering in addition to the membranes of the cord and integument.

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